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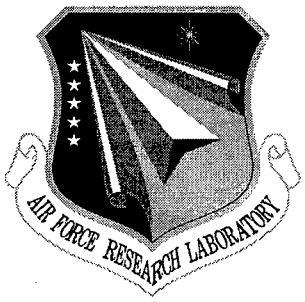

A COGNITIVE APPROACH TO DEVELOPING PLANNING TOOLS TO SUPPORT AIR CAMPAIGN PLANNERS

Klein Associates, Inc.

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13. ABSTRACT *(Maximum 200 words)*

Report developed under SBIR contract. Artificial Intelligence methods can rapidly generate detailed plans for complex situations. However, these plans may be rejected by planning experts, who judge dimensions such as robustness using operational rather than computational criteria. Our goal in this research was to capture the tactical and strategic concerns of air campaign planners, and incorporate these into planning technology to assist with filtering out the unacceptable options and highlighting preferred plans. Specifically, we focused on identifying characteristics of quality plans and how these characteristics are judged in operational settings. We used a variety of knowledge elicitation techniques in the Cognitive Task Analysis (CTA) to identify the process of plan evaluation and the factors underlying judgment of plan robustness. Our research drew on observations and interviews in a variety of settings: The primary data sources were from Joint Force Air Component Commander (JFACC) exercises and from a simulation exercise with Pentagon planning staff. The CTA formed the foundation of a software tool, the Bed-Down Critic, which highlights potential problem areas, vulnerable assumptions, and summarizes aspects of quality to the user.

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Introduction

"The grand strategic level of war is the place where the most basic but most consequential decisions are made."
— John A. Warden III

With technology comes change. Advanced technology is enabling advances in planning domains that, until recently, were not possible. The number of these advances, and pressures to change the nature of how planning is done, will continue to grow steadily as we approach the 21st century. These changes are creating new opportunities for how to plan and execute air campaigns, but they do not come without their own set of new challenges.

As technology continues to progress, the areas of application for which they are designed must adapt as well. Air campaign planning is currently in a state of evolution, and the needs and capabilities of the air campaign planner are changing with it. With the rapid state of technological growth there is a parallel need to develop these systems so that they can be used operationally. These new systems need to be designed with the human operator in mind. The new technologies need to support the decision making of the expert, as well as less-experienced planners.

The tactical and strategic concerns of the human planner as plans are evaluated were central to this Phase II SBIR project. Technological advances in available computing power and advances in artificial intelligence have produced very impressive automated and semi-automated planning systems, yet a large gap remains between what is technically feasible and what is truly needed to support the needs of the human planner. Too many advanced planning systems focus more on the information architecture as opposed to the functional architecture of the human decision. In Phase I of this project (Miller & Militello, 1995), Klein Associates demonstrated the feasibility of using a Cognitive Task Analysis approach to identify aspects of quality plans that human planners look for in "robust" plans. The criteria these planners used were operational rather than computational criteria. The focus of this Phase II project was to deepen our understanding of, and capture the strategic concerns of, the human planner, and to incorporate these findings into mixed-initiative planning technologies to assist the planner by filtering out unacceptable options and highlighting preferred plans.

We selected the air campaign planning domain for several reasons. Since inefficiencies during the Gulf War have surfaced, the planning community has been expanding and evolving both conceptually and operationally to improve the planning process. Also, the sheer number of new technological developments has increased the potential for considerable improvements to the planning process. As a result, much attention is being focused on air campaign planning. The need for continued attention will remain, especially in light of the fact that the U.S. is more likely in the future to participate in joint and coalition operations with both warfighting and peace keeping operations.

To best leverage technology in the planning process to truly support the needs of the planner, we relied on a Naturalistic Decision Making (NDM) approach to first identify the decision requirements involved in the planning task. Klein Associates has extensively studied NDM, which focuses on tasks where decision making occurs under high stress, the situations are dynamic and have varying levels of uncertainty, and there are extreme time pressures to perform without error. We also have a great deal of experience studying teams and have used our understanding of team performance and decision making to further refine our understanding of human planning in the air campaign planning domain.

We also participated in and took advantage of resources from the DARPA/Rome Laboratory Planning Initiative. (Note that the program is now known as Planning and Decision Aids (PDA) and Rome Laboratory is now called Air Force Research Laboratory.) This large-scale research program ran parallel to this effort and enabled Klein Associates to gain access to the expertise of the human planners, but also allowed us to better understand the technological developments that were in progress, particularly in the field of Artificial Intelligence. This access to other technologies afforded us additional insight into the air campaign planning domain.

The Phase II Objective

One objective of this project was to understand and document the cognitive aspects of human planning at the strategic level. We specifically examined the planning done by strategic planners at the Pentagon and by JFACC (Joint Force Air Component Commander) level planners. This resulted in an identification of the types of decision making that were necessary in order to develop sound air campaign plans. A second objective was to use this understanding as a basis for developing planning and evaluation tools that would support the human planner in creating more robust plans, utilizing Artificial Intelligence technologies where appropriate.

The objective of developing planning and evaluation tools came to fruition in the development of the Bed-Down Critic. The Bed-Down Critic (BDC) was designed to assist air campaign planners develop a bed-down plan for a new scenario, or to evaluate an existing bed-down to assist in strategy development. The bed-down plan is the initial placement of resources in the theater and battle. This initial placement is important to the development of an air plan, and is dependent on situational, political and logistical factors. These factors contribute to making bed-down planning an interesting, relatively self-contained, portion of the overall plan.

The bed-down problem has become more important since the end of the cold war as a result of the increase of rapid response missions in which the U.S. now participates. During the Cold War, our assets were already forward-positioned. However, since the Cold War, there has been a dramatic reduction in U.S. forces, and in the number of overseas bases that are available to U.S. forces during a crisis. These current circumstances make the initial bed-down plan more difficult to develop and more critical to the success of the mission.

In brief, the BDC uses a map-based interface that is manipulated using an icon-based architecture. Agents monitor various aspects of plan development and quality, alerting the user to

potential problems through tripwires, dialog windows, and an agenda. The BDC has been demonstrated and received well in several Technology Integration Experiments (TIE), the third of which took place in the TIE facility at DARPA headquarters in Arlington, Virginia. The Bed-Down Critic is more fully described in the last section of this document.

The Research Team

The development team for this project included the research staff at Klein Associates, analysts from Synergy, Inc., who had access to domain expertise and technical knowledge and software developers from Stottler-Henke Associates, Inc. (SHAI) and SRI International. Klein Associates was responsible for coordination among the team members, for the collection and documentation of the knowledge elicitation data, for development of the conceptual framework based on the data acquired, and for maintaining the integrity of the conceptual framework during the development of the Bed-Down Critic.

Synergy was instrumental throughout the project and provided relevant domain-specific knowledge and insight into the air campaign planning domain. They were responsible for creating the Air Counter '97 (AC '97) planning scenario by adapting a land-based scenario to one that was more amenable to the use of air power. The quality of the AC '97 scenario was critical to the success of the planning exercise in that it provided a realistic situation for the participants to build a plan against. They also coordinated with the planning staff at CHECKMATE, where the exercise was hosted and filled the role of adjudicator during the exercise itself. Synergy was a continual source of domain-specific knowledge throughout the project and they facilitated the development and refinement of the Bed-Down Critic by providing important insights into the air campaign planning community.

SHAI, Inc. was responsible for developing the interface and the system architecture. They were instrumental in producing a usable tool that supported the concepts of air campaign planning that had been revealed throughout all of the knowledge elicitation sessions conducted by Klein Associates. SHAI's expertise in understanding human-computer interaction, and clear understanding of the conceptual framework of the tool facilitated the development of the Bed-Down Critic using evaluation algorithms formulated by the research staff at SRI International.

Research staff from SRI International were instrumental in developing many of the evaluation algorithms for the Bed-Down Critic and they contributed to the system architecture design. They also participated in the AC '97 simulation exercise. SRI staff developed evaluation algorithms based on the relationships among planning criteria that were revealed in the AC '97 exercise and at other knowledge elicitation sessions. SRI staff also contributed to the design of the system architecture.

About This Document

The first section of this document will describe the Naturalistic Decision Making techniques and methods that were used to perform the knowledge elicitation sessions. Each source of

knowledge elicitation will be presented in brief, with references to documents that treat the subjects more exhaustively.

The second section will highlight the findings from the knowledge elicitation sessions from this project. The findings from our knowledge elicitation can be broken down into three main areas: the planning process; aspects of quality plans; and plan evaluation. Our findings are briefly summarized in this document. For a more detailed account of the findings from specific knowledge elicitation sessions, please refer to Appendices A-C.

The final section of this document describes the development of the Bed-Down Critic. This section describes the link between the concept for the Bed-Down Critic and the Air Counter '97 exercise, the resulting prototype functionality, and planned future technology enhancements of the system.

Methodology

This section discusses our approach to data collection, the individual interviews we conducted, and the Air Counter '97 exercise that was hosted by CHECKMATE in 1997.

Naturalistic Decision Making

Our approach to understanding the human planner is based on a relatively new field within psychology called Naturalistic Decision Making (NDM). Klein Associates has pioneered this approach and continues to promote its development as a sub-discipline within psychology (Klein, Orasanu, Calderwood, & Zsambok, 1993; Zsambok & Klein, 1997). NDM is the study of how humans make decisions in naturalistic environments. That is, we study how the decision maker makes decisions under real time pressure, high stress, conditions of uncertainty and dynamic conditions, and where stakes are high. We study decision makers in their domains of expertise in the real world; not in a laboratory or artificial environment.

Our methods are designed to understand and to provide insight into the decision-making process in order to allow us to identify critical aspects of the expert's cognitive processes. In order to accomplish this we employ a suite of tools called Cognitive Task Analysis (CTA). CTA provides us with methods for eliciting general domain knowledge and specific knowledge pertaining to the cognitive requirements for the critical decisions and judgments made in the air campaign planning environment. The NDM theoretical orientation, coupled with the specific CTA findings, leads to the identification of cognitive requirements for planning, and ultimately in this project to the design and development of the Bed-Down Critic (See Figure 1).

The Cognitive Task Analysis allows us to go beyond the procedural textbook knowledge and the behavioral aspects of a task that are traditionally elicited and represented by other task analysis methods (e.g., behavioral). The purpose of the CTA is to get inside the decision maker's head to understand the cognitive components that guide the decision-making process. This requires a high-level understanding of how the human planner conceptualizes air campaign

planning, and how they assess the critical cues, expectancies, goals, and sub-goals that are required to make a decision in a specific context.

CTA is not a single "tool," but rather it is a collection of tools for collecting and analyzing data succeeding the judgments and decisions of a task. For this project, we employed CTA to allow us to understand the cognitive aspects of those who plan the air portion of large Joint Task Force (JTF) campaigns. These aspects include the judgments, decision-making, and problem-solving skills that are critical in the time-pressured, uncertain, and ever-changing air campaign planning domain. To allow us to understand both the high-level conceptualizations and the low-level information gathering and interpretation that takes place, Klein Associates used a number of specific knowledge elicitation tools designed to address these various levels. Included in these were the Knowledge Audit, the Critical Decision Method (CDM) (Klein, Calderwood, & MacGregor, 1989), and Simulation Exercises (e.g., AC '97).

The Knowledge Audit is organized around knowledge categories that have been found to characterize expertise (Militello, Hutton, Pliske, Knight, & Klein, (1997). These include: diagnosing and predicting, situation awareness, perceptual skills, developing and knowing when to apply tricks of the trade, improvising, metacognition, recognizing anomalies, and compensating for equipment limitations.

The Knowledge Audit employs a set of probes designed to describe types of domain knowledge or skill and elicit appropriate examples. The goal is not simply to find out whether each component is present in the task, but to find out the nature of these skills, specific events where they were required, strategies that have been used, and so forth. The list of probes is the starting point for conducting this interview. Then, the interviewer asks for specifics about the example in terms of critical cues and strategies of decision making. This is followed by a discussion of potential errors that a novice, less-experienced person might have made in this situation.

The examples elicited with the Knowledge Audit do not contain the extensive detail and sense of dynamics that more labor-intensive methods such as the Critical Decision Method incident accounts often do. However, they do provide enough detail to retain the appropriate context of the incident.

CDM interviews rely on eliciting memories of particularly challenging situations, especially where one's expertise has been challenged. Although memories cannot be assumed to be perfectly reliable, the CDM method has been highly successful in eliciting perceptual cues and details of judgment and decision strategies that are generally not captured with traditional reporting methods (Crandall, 1989). This was certainly true during specific interviews during this project (i.e., Gen. Charles Horner and Col. John Warden). CDM provided this information from the perspective of the person performing the task, and was particularly useful in identifying cognitive elements that were central to their proficient performance. Detailed descriptions of CDM and the work surrounding it can be found in Klein (1989) and Klein, Calderwood, and MacGregor (1989).

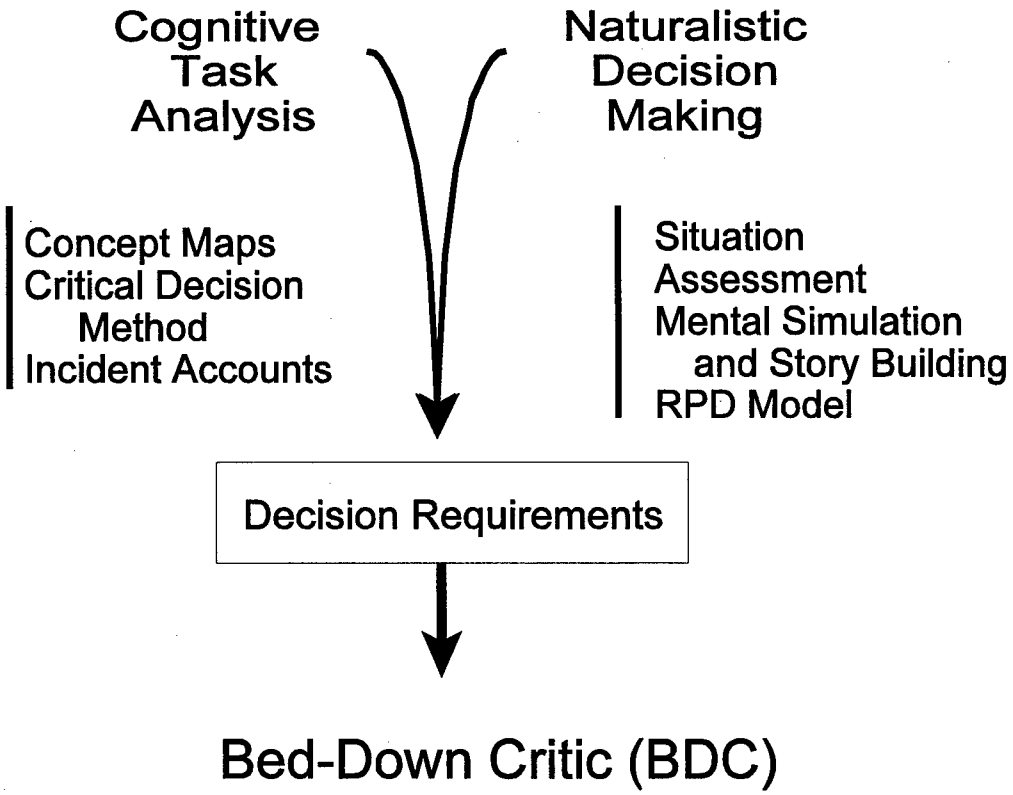

Figure 1. NDM orientation for development of Bed-Down Critic.

Simulation exercises are used in situations where making observations of team dynamics is important (Miller & Lim, 1993). The process for conducting a simulation exercise starts with the careful development of test cases, or scenarios that the participants will work through during the exercise. These materials need to be designed so that events during the exercise will give insight into the research questions that are being asked. For example, in AC '97, the scenario was developed so that there were several options available to the planners, all of which had at least one drawback. Thus, the scenario set the stage for discussion about the advantages and disadvantages of each option, giving us insight into what planners look for in quality plans. In addition, the makeup of the participants in simulations exercises is such observations can be

made of interactions among participants having differing expertise. These interactions often yield insights into how decisions are made, and where technology can be leveraged.

Observations

Klein Associates' researchers collected data for this project from three sources: 1) observations made at JFACC exercises, 2) interviews with 16 experienced planners, and 3) the AC '97 simulation exercise.

JFACC Exercises. We attended three live exercises where JFACC planning staff developed air plans that were actually flown during the exercise. The first exercise we attended was Roving Sands 1995. We had one observer stationed at Roswell, NM where he observed the planning staff of the Red Team. Since this was the first exercise we observed, it was used primarily to make contacts within the JFACC community and to become familiar with the JFACC planning process.

The second exercise we attended was JTFEX 95-3. The JFACC planning staff for this exercise were stationed aboard the USS. Kittyhawk, which was docked at San Diego for the exercise. Two research staff from Klein Associates observed this exercise and conducted interviews with the planning staff as opportunities arose. This second exercise allowed us to explore issues identified from the first exercise, and to deepen our understanding of the JFACC process.

The third JFACC exercise we attended was JTFEX 96-1, which was conducted by the George Washington Carrier Battle Group at sea in the Atlantic ocean. One of our research staff spent seven days with the JFACC planning staff aboard the USS Mount Whitney, which is the command and control ship for the carrier battle group. This exercise was again used to further explore issues identified in earlier exercise observations, but also to specifically focus on the characteristics of quality plans, how the JFACC staff knows when they have a good plan, and where in the process there are opportunities to evaluate the quality of the plan. During this exercise, we also made contacts with the planning staff at Barksdale Air Force Base, who were responsible for developing the air plan for JTFEX 96-1. We conducted follow-up interviews with six members of the planning staff at Barksdale after JTFEX 96-1 to explore specific plan evaluation issues.

Individual Interviews

Data collected from interviews with 16 military personnel with planning experience contributed to our understanding of the planning process, aspects of quality plans, and opportunities to evaluate plans. Below, we briefly review a few of these interviews, with emphasis on individuals with exceptional planning experience.

Colonel John Warden, USAF (Retired)

Colonel John Warden served as the head of CHECKMATE just prior to, and during, the Gulf War. As such, he played an important role in the planning that occurred in preparation for Gulf War air operations. He oversaw the planning process at CHECKMATE and served as an informal evaluator of the plans developed by CHECKMATE personnel.

During his career, Col. Warden also became the lead proponent for a Centers of Gravity approach to air campaign planning, which he called his "Five Rings Approach." The goal of this planning process is to remove the inner capability of an adversary in order to cause its entire military system to collapse under its own weight. Warden has written multiple documents describing his Centers of Gravity approach. (For a brief description of the approach, see the *Warden Interview Notes* in Appendix A.)

We conducted a four-hour interview with Col. Warden regarding his experience at CHECKMATE and his approach to air campaign planning. Our focus centered on quick response planning as opposed to deliberate planning. We used the Critical Decision Method to elicit a collection of incidents from the Gulf War on which we would base our questioning. The incidents we probed for were those in which Warden made a judgment regarding the quality of a plan, "fixed" a plan, or was heavily involved in creating a plan. Our primary goal was to determine the aspects of high versus low quality plans.

Nine specific incidents from Col. Warden's Gulf War experience were elicited and probed, resulting in a fruitful discussion of the issues surrounding planning and the process of planning. In our interview notes, we captured six critical planning issues that arose in our discussion with Warden, as well as the nine incidents he described. The issues documented shed light on the characteristics of high quality plans, as well as considerations pertaining to other aspects of planning and the process of planning. The incidents serve as real-world examples of high versus lower quality plans and other issues that arise during the planning process.

The first draft of the interview notes was sent to Col. Warden for his review and comments. He responded by writing additional remarks which elaborated on or clarified our understanding of the planning issues and incidents. We have included his written comments in the final version of the interview notes, which we have appended (see Appendix A).

In addition to the knowledge gained during our first interaction with John Warden, we requested additional input regarding evaluation of air campaign plans. Per our request, Warden prepared a document entitled, "A Good Air Campaign Plan and How to Measure It." The document presents and discusses eight questions that an evaluator should ask regarding the plan and the process which derived the plan. The purpose of these questions is to stimulate the evaluator's thinking and enable him or her to be comprehensive in judging the quality of the plan. This document is included in Appendix B.

General Charles Horner, USAF (Retired)

General Charles Horner was the Joint Force Air Component Commander (JFACC) during the Gulf War and he served under General Schwarzkopf. Gen. Horner was in a key position during the war to evaluate air campaign plans as they were developed. Due to his role during the war, no plans were implemented without his approval. For our purposes, we interviewed Gen. Horner to discuss specific incidents where plans were not approved in order to gain an understanding of why they were not approved. We were interested in what was missing or erroneous about these plans, and how these plans could have been better.

Our first step with Gen. Horner was to send him a list of open-ended questions about his experience in air campaign planning for the Gulf War. Gen. Horner responded to these questions using a free protocol method and recorded them on tape. These tapes were then returned to Klein Associates for transcription and analysis.

We analyzed the transcriptions for content, and identified issues or events that we wished to ask Gen. Horner to elaborate on. We constructed this list of follow up questions and presented these to him in a five hour long interview conducted at Klein Associates. This interview was also taped. We later transcribed this tape and added our handwritten notes for analysis. From this analysis we identified several planning and evaluation issues.

These issues were refined and elaborated on during a final knowledge elicitation session that was conducted in the same manner as our initial free protocol method. Gen. Horner was sent another revised list of questions that were aimed at filling in the gaps in our knowledge of specific incidents based on the previous interviews. The taped responses to these questions were again returned to Klein Associates, and the information was transcribed.

Gen. Horner's discussions resulted in our identification of 10 planning issues (for a more detailed description please refer to Appendix C). These issues were documented and then sent to Gen. Horner for correction and approval. These ideas were instrumental in our planning for the AC '97 scenario.

Barksdale Air Force Base. Planners from the 8th Air Force were largely responsible for developing the plans used in JTFEX 96-1 on the USS Mount Whitney. We traveled to Barksdale AFB to speak with members of the 8th Air Force regarding their roles in planning air campaigns. Interviews were conducted with representatives from the Guidance, Apportionment, and Targeting (GAT) Cell and the Night Plans Cell. In total, 8 people were interviewed, including the Chief of Combat Intelligence, the Chief of Strategy, the Assistant Chief of Plans, a weapons expert, and an Army liaison.

The interviews were semi-structured, CDM-like sessions lasting approximately 2 hours. The sessions began with a discussion of the interviewee's background in the Air Force and path by which he or she became an 8th Air Force planner. Our goal was to understand the knowledge and experience base possessed by the typical planner. We then continued our questioning by eliciting

specific incidents experienced by the interviewee either during the course of an exercise or in a real-world operation. Our goal here was to probe into events in which the planning process has fallen apart in order to gain an understanding of the barriers to effective planning. Finally, we initiated a discussion of the characteristics of quality plans. We asked the interviewee about incidents in which they felt their plans were strong, and incidents in which their plans had to be altered significantly following its briefing to higher level personnel. The purpose of this line of questioning was to identify aspects of plans that make them robust and thus acceptable for use in an operation.

For each interview, notes were written by the interviewers to recapture key points and issues that arose during observations at JTFEX 96-1. We then analyzed the interview findings through a series of discussions, which contributed to our compilation of planning issues and characteristics of quality plans.

Simulation Exercise: Air Counter '97

The Air Counter '97 (AC '97) exercise was the last and most extensive of our knowledge elicitation efforts. In knowledge elicitation work prior to AC '97, it became clear that there is no formal (explicit) aspect of the planning process where evaluation takes place. In order to study plan evaluation, we designed AC '97 to explicitly engage experienced planners in evaluating plans. We did this by having two teams of human planners separately develop plans against the same scenario. After the teams developed their respective plans, each team commented on, and evaluated the other's plans.

During the exercise, we were able to focus on the planning process and observe actual planners construct and evaluate an air campaign plan. The exercise enabled us to reveal the CHECKMATE process in order to observe and document the formal and informal evaluation process and criteria, and to identify the areas where human planners had difficulties within the planning process. The exercise also helped us identify a specific problem area (i.e., bed-down) for technology development that would fit within the scope of this Phase II project.

AC '97 was a three day planning exercise hosted by the CHECKMATE office in the Pentagon. The exercise was designed to simulate many attributes of actual planning events. Data produced from the exercise includes the maps containing the Initial Preparation of the Battlefield (IPB), the bed-down plans, interview and observation notes, and briefing viewgraphs containing the plans from the two teams. Results from this exercise, including a detailed account of the scenario, can be found in a separate document (Miller, Copeland, Heaton, & McCloskey, 1998).

The AC '97 planning scenario was developed by staff at Synergy and was based on an air alternative to the Army Land Warfare 21 wargame scenario. The exercise and subsequent interviews all took place at the CHECKMATE offices in the Pentagon. Seven CHECKMATE planners participated in the exercise. Also, teams from Klein Associates, SRI, Rome Laboratory, and Synergy observed the planners during this three-day exercise.

During the first part of day 1 of the exercise, the planners were all present and were briefed on the situation by the adjudicator from Synergy. Planners jointly performed the Initial Preparation of the Battlefield and Red Course of Analysis. After the planners had a shared understanding of the situation, the planners were split into two teams consisting of three people.

During the second part of day 1, the planning teams worked on a Concept of Operations (CONOPs) development and a strategic approach to the simulation scenario. Each team worked independently in developing a campaign plan. The planning continued through the morning of day two, and was observed by members of the research team.

On the afternoon of day 2, the teams briefed their plans to each other for critique. The briefings were open to questions and discussion by both the planners and the observers, in order to provide insight into specific evaluation issues.

On the morning of day 3, the research team conducted individual interviews with the all of the planners who participated in the exercise. The purposes of the interviews were to 1) clarify issues raised during the observation portion of the exercise; 2) elaborate on the evaluation criteria used both when developing a plan and formally briefing the plan; 3) elicit opinions and issues not expressed in the open forum the day before.

AC '97 produced a wealth of information on the planning process, including sources of data used to develop plans, and the evaluation of plans (see Miller et al. 1998). This exercise was instrumental in shaping the remainder of the project. One of our key observations was that bed-down considerations (the placement of initial resources in the theater of operation) occur very early in the planning process and that errors made here will propagate through the rest of the planning process until detected and corrected. Since any initial bed-down errors can have such a dramatic effect on the entire planning process, we decided to make bed-down plans the focus for system development. This is discussed in the final section of this report.

Findings

This section briefly summarizes our CTA findings, which are organized around three aspects of planning: the planning process, aspects of quality plans, and plan evaluation. For more information, see Miller et al. (1998).

The Planning Process

Throughout the knowledge elicitation efforts within this project, several themes emerged concerning the process of air campaign development and evaluation. First, *the planning process is iterative and never finished.* Because there are so many unknowns in situations that the military becomes involved in, one can never assume that all of the conditions that are known will remain stable and unchanged throughout the planning cycle. Therefore, it is impossible to create one "perfect" plan, or to even have one planning process. Human planners must operate in this environment of uncertainty and time pressure where there is always more preparation that could

be done if time were available. We did not find planners striving to create the "best" plan, but rather they were developing plans that would meet the objectives given the time available. The planners in our CTA strived for feasible plans that addressed the constraints and relevant trade-off issues for a given situation.

In the best planning we observed, *planning is objective-based and top down.* For example, one of the first steps in strategic-level planning is to break out air objectives (objectives where the use of air power can be executed) from a list of campaign objectives that come from the National Command Authority (NCA) and/or from the Joint Force Commander (JFC). From this list of objectives, planners develop tasks to fulfil one or more of the objectives. As the web of tasks are developed, the planners must continually recheck the stated objectives to ensure that what is tasked will perpetuate the campaign strategy. The iterative, top-down process continues as tasks and objectives are revisited, refined, and restated to more fully clarify specific actions that need to be taken.

We also noted in the CTA data that the *planning process should support strategy development.* The strategy for the campaign evolves as the plan is developed and a good planning process needs to support the evolution of strategy. An initial strategy is developed for a given situation, but as the situation changes or new information is obtained, strategy should adapt as well. Thus, not only is the planning process itself iterative, but so is the strategy development. Robust planning necessitates having the flexibility to address dynamic circumstances or changes in the given situation. A strategy that fails to adapt to changing conditions is one that can be taken advantage of by an opponent.

Aspects of Quality Plans

A quality air plan must strike a balance between various aspects of a plan in order to be robust. Failure to explicitly consider these aspects of plans can yield a plan with vulnerable approaches to achieving the objectives stated. A key component to evaluating a plan during its development includes an understanding of the inherent trade-offs between certain characteristics of a plan. Specifically, our CTA data suggest that robustness of air campaign plans needs to consider at least the following plan characteristics:

- Risk to forces
- Coordination among plan components
- Flexibility in applying the plan
- Sensitivity to geo-political issues
- Resource utilization
- Communicating intent of the plan
- Measurability of plan progress
- Ownership of initiative

Considerations of risk include understanding risks to friendly forces (i.e., location and proximity, and configuration of friendly command-and-control structures), risks to bases (i.e.,

location and proximity to Special Forces, missile, and other air attacks), risks to aircraft and mission success (i.e., mobile air defenses), etc. Planners are faced with the task of knowing where the sources of risk are and then balancing this risk to friendly forces with the potential consequences of not taking certain actions.

Coordination issues are difficult for any large-scale operation, but they are greatly complicated by joint or coalition military forces. Coordinating activities in the planning stages can help alleviate confusions and miscommunications that can occur during the execution of a plan.

Having adequate flexibility is the next aspect of quality plans. The ability to change with dynamic conditions and not being locked to certain actions, regardless of inopportune timing or conditions, is imperative to successful planning. The General we interviewed described this as being "a prisoner to the plan." Using plan components that can be used in multiple ways is one way to build flexibility into a plan. In the air campaign planning domain, for example, one way to build in flexibility is to use aircraft that can perform multiple missions. That is, specific aircraft are tasked with certain missions, but if the need arises, these same aircraft can be redirected to another, more time critical task such as providing combat air support to ground troops. If the need does not arise, the aircraft performs its primary mission.

Understanding geo-political, cultural, and political motivations of the opponent (i.e., "being able to plan through the enemies' eyes") enables the planner to predict the opponent's reaction to actions taken. Without this understanding, actions may not have the intended effect.

A critical aspect of any quality plan is the efficient use of resources. Knowing which resources have limited availability, and are therefore constraints to the set of feasible plans, is critical to building sustainable plans. For example, during the Gulf War cruise missiles were a limited resource, and planners needed to use them sparingly and efficiently.

Throughout the planning process it is also important that the planners consider how to communicate the intent behind the development of the plan. Planners may develop a series of tasks that they have clearly linked to stated objectives, but they may fail to document or otherwise communicate these links. Without an understanding of the intent behind a task downstream in the planning and execution process, those who implement the tasks will be unable to improvise if the situation requires adaptation of the plan.

The ability to measure the progress of plan implementation should be built into the plan. Tasks should be stated in such a way that realistic observations can be made that are relevant to assessing progress. Measuring plan progress is an area that is currently evolving. For example, measures of effectiveness of the plan have traditionally been tied to the reduction of enemy forces or their resources. However, current thinking links implementation of tasks with an effect on opponent functionality or capability. For example, it may not be necessary to reduce an opponent's aircraft supply by 50% if a few well-placed precision weapons can disable command

and control of those aircraft. This current way of thinking about measures of effectiveness has increased the need for clearly specified measures that are built into the plan.

Several participants interviewed in our CTA discussed the importance of having and maintaining the initiative in a plan. While very difficult to measure, having the initiative refers to the ability to force the opponent to react to your actions and not being forced to react to your opponent's actions.

Plan Evaluation

We found that plan evaluation takes place both informally and in more formal settings. The most obvious place where plan evaluation takes place is in formal settings such as when a plan is briefed to the commander. Briefing the plan gives superior officers the opportunity to weigh whether the given plan meets the required military, political, and national objectives. Thus, during formal evaluations it is not only imperative that the plan address the necessary objectives, but that the plan is presented such that it is understandable to those who are doing the critique. Thus, "marketing" the plan is as much a part of the evaluation process as is anticipating the evaluation criteria that will be used.

We also found that evaluation can also be informal in the sense that it is iterative, tightly coupled to plan development, and is continuous throughout the planning cycle (Klein & Miller, in preparation). Evaluation occurs within the development of the plan and we found that members of the planning staff take the responsibility for questioning the plan or pointing out discrepancies within it.

This incremental evaluation is concurrent with plan development. We observed team members noticing details in the plan that could become problems downstream in the process, such as having the wrong kind of support equipment for F-15s and at a certain airbase. We also observed instances of backing up in the process to reconsider aspects of the plan, or reviewing the entire plan to maintain situation awareness. Another form of incremental evaluation is the use of specialized software tools. For example, there is software available to help planners "de-conflict" flight paths of aircraft in a crowded sky.

One of the goals of this project was to use the results from the CTA to identify where AI-generated plan techniques could be used to support the human planners with respect to plan evaluation. We identified a slice of the planning problem, called "bed-down," on which to base a prototype support tool that would assist planners critique the quality of their bed-down plan. **Bed-down refers to the initial placement of resources in theater**. In the work described here, this refers primarily to the placement of aircraft and logistic support at friendly airbases.

The Bed-Down Critic

The prototype Bed-Down Critic (BDC) is a planning system that assists planners in allocating resources and provides high level plan evaluation functions. The concept emerged from the Air

Counter '97 simulation exercise. The BDC can either be used to modify an existing bed-down, or support the development of an initial bed-down plan. The BDC system also supports a strategy-to-task approach. It is a tool that allows the human planner to evaluate the planning process as the bed-down is being developed.

The plan evaluation functions are driven by manual (interactive) inputs on a map-based interface. The BDC provides estimates of feasibility, effectiveness, and threat in order to guide force allocation. The tool provides high level evaluation estimates, as well as the intermediate information on which these estimates are based. The user can see more of the process and understand the trade-off issues and other factors that were created within the development of the bed-down plan.

The Bed-Down Problem

During Air Counter '97 it became clear that the initial bed-down of resources is important to the development and refinement of an air plan. Situational, political, and logistical factors all factor into the unique problem of bedding-down resources in a theater of battle. The bed-down problem has become more important since the end of the cold war as a result of the increase of rapid response missions that the U.S. now participates in. During the Cold War, our assets were already forward-positioned. However, since the Cold War, there has been a dramatic reduction in U.S. forces, and in the number of overseas bases that are available to U.S. forces. These current circumstances make the initial bed-down plan more difficult to develop and more critical to the success of the mission.

The bed-down plan is not simply placing assets at various bases. The bed-down involves having an understanding and strategy for how limited assets can be most effectively used, and where those assets should be located to accomplish tasks in the most economical and compatible fashion, all the time maintaining low levels of risk to the mission success (e.g., loss of life, loss of assets, loss of time, etc.). Just as the development of strategy will drive the initial bed-down, refinements or changes to the bed-down can also facilitate changes in the strategy. In this sense, the bed-down plan is instrumental to the transition between the strategy and the implementation of the campaign plan.

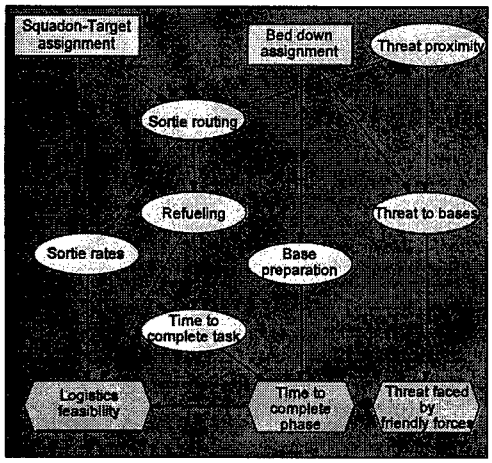

Figure 2. Influence Diagram.

The Bed-Down Critic

The Bed-Down Critic supports the development and evaluation of the bed-down process. It provides feedback for 1) total aggregate risk, 2) time-to-completion, 3) logistics constraints, and 4) compatibility issues. An influence diagram of the system architecture is shown in Figure 2.

The system uses a map-based interface where objects such as squadrons, bases, target sets, and threats are displayed as icons that can be directly manipulated by the user. The user can also access information about objects and modify object information (e.g., Desired Mean Points of Impact (DMPI), make up of target sets base preparation times, etc). The basic user interface is shown in Figure 3.

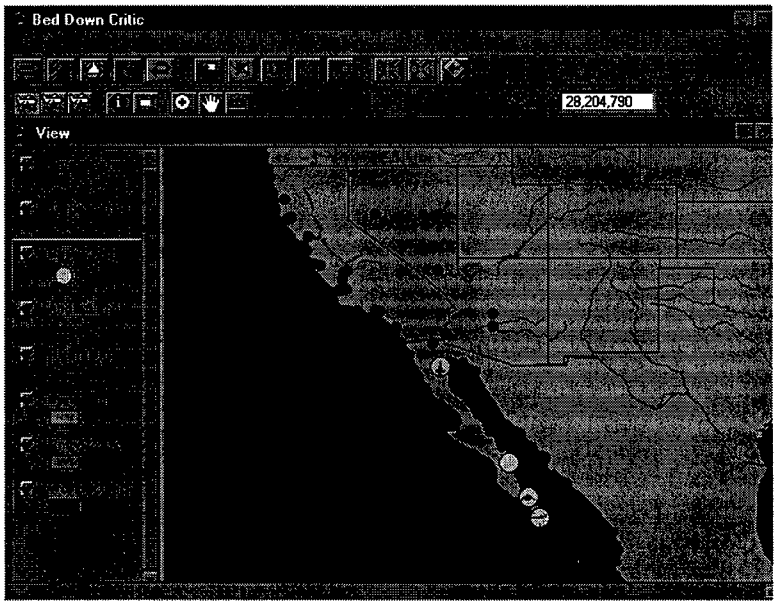

Figure 3. Bed-Down Critic: Basic user interface.

The user can physically move squadrons to different locations, and create one-to-one squadron to target pairings (assign squadrons to targets), (see Figure 4). The user can also quickly and easily label squadron, base, target and threat names on the map for rapid identification.

The user has the ability to set and modify theater-level variables such as the likelihood of attacks from special forces, supply reserves and resupply rates, and the required level of destruction required when attacking targets. Most of the theater-level variables are qualitative judgments that should (and would normally) be provided by the human planner.

The BDC supports rapid assessment and evaluation of the bed-down via graphical representations of evaluation criteria. An overall evaluation window is shown in Figure 5. Within this window, the user can see aggregated evaluation of the logistics availability, time-to-completion, and aggregate risk for the currently planned bed-down. This window displays text-based feedback in a browser-like environment that allows the user to drill down into the details of higher level, aggregated assessments.

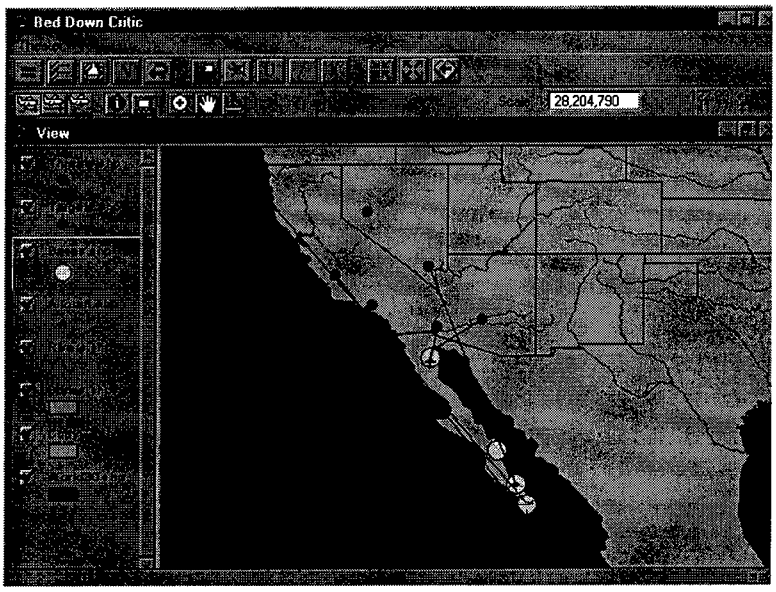

Figure 4. User interface.

For example, in Figure 5 we see that the completion time for Visalia Soc (an enemy target) is five days. However, in the test scenario from which this screen was taken, the commander specified that this target should be non-operational within two days. The user drills down into the Visalia Soc by clicking on it, to reveal more detail. We can see that the Visalia Soc is targeted using F-15e-1, that it will take 36 sorties, and that there will be nine sorties per day. Are human planners know that nine sorties per day is a very low rate and that this is the source of the long time needed for completion time. The planner now has several options to increase the sortie rate, including actions such as locating the fighter aircraft closer to the target, or allocating more fighter aircraft to the target.

A second example is shown in Figure 6. The user has drilled down in the risk window for San Felipe (a friendly airbase) to examine why risk is high. The user has discovered that the threat to the base at San Felipe is extremely high, and that a major source of this threat is coming from the enemy airbase Yuma Airfield. By drilling down deeper (not shown) the user discovers that there are no Patriot batteries at San Felipe. If the user were to add two patriot batteries, the level of risk would come down to average.

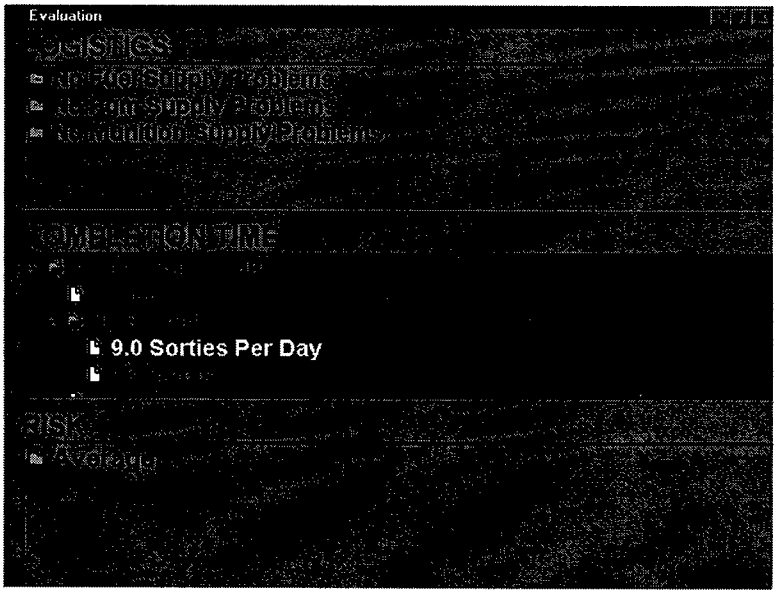

Figure 5. Evaluation window for BDC.

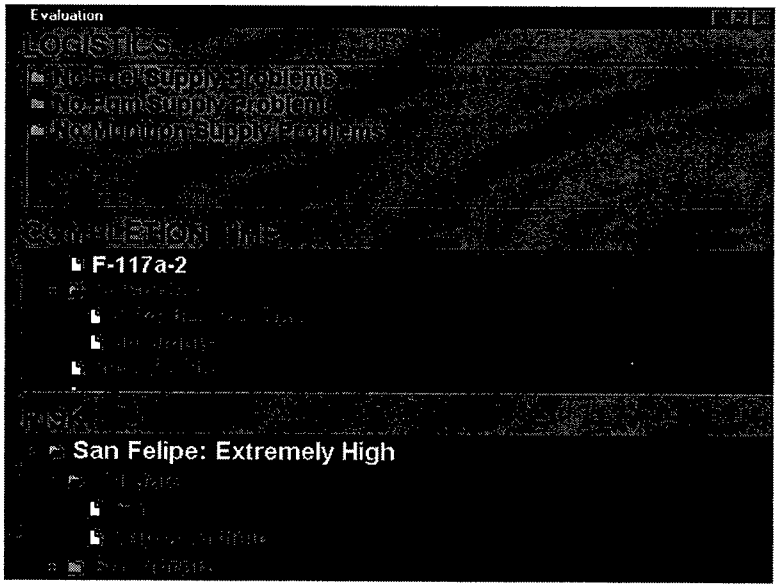

Figure 6. Risk window for BDC.

Other forms of rapid evaluation feedback are implemented in the form of tripwires and agendas. Besides the aggregated evaluation window, the system also alerts the user when specific constraints or trade-offs have been identified. These warnings are displayed when specific actions are taken (i.e., the user moves a squadron to another base) and a constraint is violated (i.e., there is not enough ramp space to accommodate that squadron, as shown in Figure 7).

Figure 7. Evaluation feedback screen.

These warnings such as those shown in Figure 7, do not require the user to correct the problem immediately. The BDC also provides an "agenda" feedback. All warnings or alerts that represent a constraint violation and are yet to be resolved are recorded in the agenda. As a warning is corrected or addressed, that issue is removed from the agenda list. The user can refer to the agenda periodically to determine which issues have yet to be resolved, as shown in Figure 8.

The use of the agenda allows the user to keep track of factors that violate some specific constraint. The implementation of this feature does not force the user to solve each problem as it arises. The user can review the agenda when they are ready, and address each item in an order they choose. The BDC system does not force the user to address each and every item (unaddressed items will remain on the agenda, but this will not prevent the user from continuing to develop the bed-down). This is especially important when the user wishes to continue with a bed-down the BDC detects potential problems with, but which may be suitable for the user's needs.

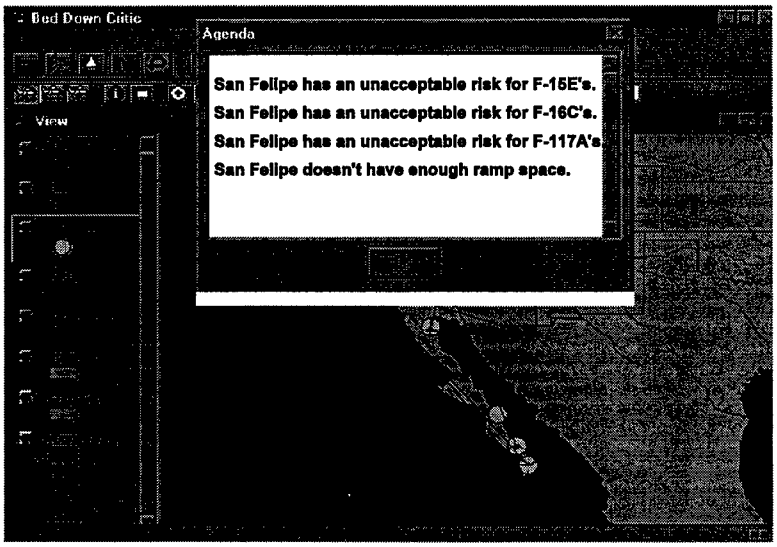

Figure 8. Agenda screen.

The tripwire and agenda features are implemented using intelligent agents, where each agent is responsible for specific constraints. They monitor user actions and when one of these actions violates a constraint, the agent immediately informs the user (tripwire). The agenda queries every agent simultaneously, and presents these warnings to the user.

Planned Future Functionality

There are several enhancements that should be considered for the next version of the Bed-Down Critic. One such enhancement involves changing the map-based architecture. The current mapping software implemented is Arcview GIS. This software enabled us to rapidly prototype the BDC system, but it constrained the amount and type of functionality that we would have otherwise included.

The map images used were from ESRI's Digitized Map of the World, and were limited in the detail that could be displayed. The Defense Mapping Agency (DMA) has developed more versatile mapping software that would be compatible with most digitized mapping formats and would enable more dynamic functionality and integration. The first step in adding future functionality would be to integrate and refine the current functionality with the DMA's Mapping, charting, and geodesy Utility Software Environment (MUSE). In addition to a new map-based software, other functionality should include:

- Squadron toolbar
- Dynamic loading/integration
- Object modification
- Extending and refining evaluation functionality

A squadron toolbar would enable the user to start with an initial basing, as it is implemented currently, or draw from assets located outside of the theater. These assets could be located either state-side or at any other staging area outside the theater of interest.

Dynamic loading and integration would involve linking the BDC system to a dynamic database. As the BDC is currently implemented, setup information (i.e, base location, locations of squadrons, targets, threats, etc.) must be loaded by the developer. In subsequent versions of this prototype this capability would be available to the user and linked to the area of interest.

In later versions, more detail and object modification would be available to the user such as threat severity, threat ranges, and squadron size. Much of this could be accomplished through dynamic loading and integration, but refinements could be made by the user as well.

Extending and refining the evaluation functionality would include factors such as assessing collateral damage, including enemy aircraft in threat considerations (and adding Combat Air Patrols as defense), providing graphical supply rates over time, adding offensive capabilities, completion time and logistics refinements, more specific considerations for uncertainties, expanding considerations for dependencies among targets and target sets, and exploiting the currently implemented evaluation functions and integrating them with other automated planning systems.

Conclusions

Initial reception to the BDC has been positive. The system has been integrated into a DARPA Technology Integration Experiment (TIE) which highlights a total of nine planning technologies. In the next phase of this research, we hope to do a thorough user evaluation, using a similar planning environment that was captured in the Air Counter '97 simulation exercise. We believer that the CTA for this project, using interviews, observations at exercises, and the three day simulation exercise, gave us unique insights into the planning and evacuating process. The Bed-Down problem allowed us to build a prototype plan evaluation system within the context of a critical, yet constrained portion of the overall planning process. Future directions of this work should move beyond the Bed-Down problem, and address plan evaluation issues in the context of the overall plan.

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APPENDIX A: Warden Interview Notes

Contract # F30602-95-C-0216

John A. Warden III Interview Notes
Revised May 26, 1999

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Revised May 25, 1999

The purpose of this document is to share with the ARPI community the results from our interview with John Warden. The first section presents six issues brought up during the interview that we believe require consideration and further examination by the ARPI community. The second section contains nine incidents related by John Warden that are relevant to our study of plan evaluation. The italicized portions are Warden's comments in response to each item in this document.

Key Issues

1. **There is no "planning community."** Other than Checkmate, there is no planning community in the sense that there is an "intelligence" community, or "operational" community, or "medical" community. Planning happens as called for, by ad hoc groups made up of people with primary expertise in fields OTHER THAN planning. These people are usually on temporary assignment from operational or technical worlds and frequently have no planning experience. Checkmate comes the closest to a "planning community", but they are quick to point out, for political reasons, that they are not a "planning cell." Also, Checkmate personnel rotate through on a regular basis, so there is a continual need to train new personnel the "Checkmate approach."

   During Desert Storm, planners came from all over and most didn't have planning experience. Warden hand-picked 20-25 people for the core planning effort at Checkmate. He picked them, not for their planning expertise, but for their expertise in fields that would help Warden build a better plan.

   This is an interesting point which raises some important questions. Who is the ARPI community building planning tools for? Who is the user? The implication of pulling planning teams together in an ad hoc fashion is that the typical user, both now and in the future, will be a novice with little or no planning experience. This novice planner may have expertise elsewhere (e.g., piloting aircraft, deciphering satellite photos, or weapon performance), but will need considerable support with incorporating his/her knowledge into the planning process. Some questions for the ARPI community are: Are we focusing on the right level of planning? Should we be building a system to support Col. Plebanic and Maj. Cardenas, or should we be building a system to support planners on temporary assignment who bring expertise other than planning to the process?

Warden's comments:

> *In Air Force organization, there are specialty codes for "planners" and people with these specialty codes think of themselves as a "planning community." They do planning, but their planning is almost exclusively in the "deliberate planning" process. That is, they work out time phased force deployment lists at local to headquarters level, they develop base disaster response plans, and do other similar projects. This kind of planning (as practiced for at least the last two*

decades in the US military) very rarely addresses development of campaign plans to achieve specific political and military objectives. Thus, the "planning community" as it currently exists has little or no experience with campaign planning. Its expertise may be of some value in actual writing of plans once concepts are developed. In addition, for a variety of reasons, people in the official planning community are unlikely to be the ones who would have the opportunity to do campaign planning.

As you noted, the real targets for a campaign planning expert system are those officers who have expertise in flying, logistics, public affairs, etc who will be asked to work at a level well above what they do on a daily basis. The expert system must help them realize that they cannot extrapolate their tactical expertise into a higher level operation; their tactical expertise is primarily valuable in giving them an intuitive feel for what is possible.

2. **Characteristics of a quality air campaign plan.** Warden's organization for planning at Checkmate during the Gulf War was flat; i.e., he didn't impose a rigid chain of command and encouraged his planners to interact with him and with each other. He often wandered around Checkmate and looked over the shoulders of the planners as they worked. Thus, he was in a good position to evaluate the work of others. This item discusses the strategies he uses and the issues he considers when judging the quality of a plan.

   Warden said that a quality plan must carry you from one state to a better end state and that great plans succeed at the Grand Strategic Level. Implementing a plan transforms you from one state to another. A quality plan improves your position. Warden defined plan as a "collection" of proposals, done in some sequence, to satisfy some objective. A quality plan includes:
   - A good analysis of the enemy.
   - An understanding of the effects of our actions on the enemy.
   - A clearly stated desired end state.
   - The specific actions needed to take you to that end state.

   Warden seems to have a set of questions that he asks himself about a plan as part of building a plan and evaluating the plan as it's built. Some of these questions are:
   - Where does/doesn't the plan move you from one state to better state?
   - Does the plan get you to your desired end state?
   - Do you understand how the plan at each level fits into the bigger plan and the overall objectives?
   - Are the expenditures "reasonable?" That is, how much loss in terms of human life, time and resources are acceptable to achieve this goal. (This can't be answered unless you know how the plan fits into the bigger picture.)
   - Can the expenditures be measured and are there measures of merit for the plan objectives?

- Are there any parts of the plan that are not linked to high level goals?
- Is there a better alternative?
- At every stage of the planning, ask yourself "why am I taking this action?"

Warden's comments:

Ref your first four bullets, the order and wording are important so I would suggest the following:

- *A set of clearly defined objectives which will lead to an explicit end state (a better peace).*
- *Strategic analysis of the enemy to find centers of gravity related to the previously defined political and military objectives.*
- *A decision as to which centers of gravity (ultimately defined as targets) will need to be affected in order to achieve high level objectives.*
- *A campaign plan to use the whole panoply of available tools (forces, information war, deception, public relations, logistics, etc) to produce the desired effects on enemy centers of gravity.*
- *Identification of measurements which will show the commander whether he is meeting his objectives (this is much more than BDA as it is normally understood).*
- *A way to execute the campaign (mission type orders, air tasking orders, etc).*
- *A clear understanding of how the operation will end meaning how, when, where, and what peace terms the opposition will sign or implicitly accept and what measures need to be taken in order to keep the gains (air or ground occupation, monitoring, economic restrictions, etc).*

3. **Physical characteristics of "the plan."** We were anxious to learn from Warden what "the plan" looks like and consists of. During the initial planning process, the plan is in planners' heads, and parts of it, such as the columns developed using the 5-ring model and the working assumptions, are up on whiteboards in their working area. The plan produced at this level consists of 10-15 view graphs that are presented to the Commander accompanied by what's in the presenter's head. The view graphs contain the following types of information: national objectives, the 5-ring layout of the country and a breakdown of that layout, specific targets to be hit, and a tentative first day schedule. The presenter provides further explanation of the view graphs and answers to the Commander's questions.

   This means that no document exists to present the high level plan with its high level objectives, its target list, and the reasoning behind the target list. Apparently, the plan is transferred from the heads of those who develop it to the head of the Commander, who then issues orders to his subordinates accordingly (given that he accepts the proposed plan). The result is that lower level units are never made aware of the high level plan, the reasoning behind it, or the objectives it addresses. It is therefore nearly impossible for them to develop "good" plans at their level, since they are not made aware of the high level objectives that their plans should be supporting. Warden was able to cite examples in which tactical level

plans developed by lower level planners did not support the high level plan or objectives. In some cases, what is considered a successful tactical operation is devastating to strategic level operations (see incident #1 for an example).

Warden's comments:

The combination of your questions and my responses may have created some confusion in this area. The following represents the approach my group used in the Gulf War planning and also what I would do the next time:

The planning process begins with assembling a core group with expertise in a number of areas. Next, the group leader outlines the situation and the grand strategic objectives (if there are none existing, he proposes some). Using a white board or some other display and capture technology, he then starts a group exercise to do the strategic analysis of the enemy (with the five ring model if desired). (From the strategic analysis will flow target systems and eventually targets.) The strategic analysis will lead in at least two directions: first, it will show the group what is not known (and needs to be known) about the enemy which then becomes tasking for intelligence organizations; second, it leads to tentative identification of which centers of gravity must be affected in order to achieve war objectives.

Next, the group roughs out a campaign concept of operations (for example, "in a short period of time, impose strategic paralysis on the enemy. Focus efforts against the enemy leadership and avoid civilian and collateral damage."). Included in the concept will be approximate forces needed, broad deception operations, psychological warfare operations, very tentative logistics support operations, timing of the campaign, and phases if indicated. All this is being done at abstract levels on the white board. When the initial process is done (probably several hours), the group breaks up into sub-groups to add details and to identify unknowns. The sub-groups report continuously on their progress which allows the leader to construct a briefing as ideas and facts are arriving. At the end of some period of time--normally quite short (a day or two)--the leader will present the concept to a CINC, the JCS, or in some cases directly to the White House. The presentation will be largely oral with supporting viewgraphs and will contain enough detail about objectives, strategic analysis, centers of gravity, targets, concepts of operation, and physical feasibility that the receiver of the briefing can reasonably accept the general approach or direct it to go in another direction. If the former, he will ask for a more thorough briefing with far more detail.

In conjunction with detailed briefing, the planning team puts together a draft operations plan which contains full rationale for what is to be done, why it is to be done, and how it is to be done. The operations plan contains as much detail as

time permits on master attack plans, deception, electronic warfare, air defense, logistics, communications, etc. If time is of the essence (frequently the case), actual operations can commence based on the operations plan. If more time is available, the approving authority can read through the operations plan and make changes as desired. This plan should be sent to every level involved in actual execution so that everyone know the whats and whys. (Note, when we sent to see General Schwartzkopf 10 days after we began the Gulf War planning, we took a full operations plan with us; it was invaluable to the group which picked up extended planning in theater. For a variety of reasons, some of the principals in the Gulf were unwilling to share information with lower echelons so a lot of the "whys" didn't get as much distribution as I believe they should have.)

The "plan" then is a combination of things: it is an oral briefing with supporting viewgraphs--or equivalent—and it is an operations plan with as much detail as time permits (although an operational level plan need not—and probably should not have—have detail which units in the field can easily add.)

In the event time is so short as to preclude any written operations plan, then the leader of the planning team should visit personally as many of the participating units as possible so as to convey as much as possible about the intent and ideas behind the plan.

With reference to your #3, the discussion about what frequently happens (high level information getting detached from a plan as it goes to the executing level) is accurate and is really the norm vice the exception.

4. **Top-down versus bottom-up planning.** Warden made the comment that a strategic planning process needs to take a top-down approach, as opposed to a bottom-up approach, to avoid having infinite options to work out in order to be successful. He also pointed out that planners typically come from operational backgrounds. Because they come from the operational world, they bring with them not only a great deal of first-hand experiences, but also a lack of planning experience. They are used to living in the present, taking action to solve immediate problems. Thinking in terms of high-level, long-range goals is not something that comes naturally to them. Because of this, these inexperienced planners tend to build plans starting from their most common, intense experiences.

By starting at this low level, inexperienced planners are incorporating a bottom-up, or data-driven approach to their planning and decision making. They are starting with personal past experiences, using them to develop high-level goals, and build a plan. We created the following example (not from Warden) to illustrate this bottom-up approach to planning:

A planner may know from experience that an F-16 aircraft is capable of carrying munitions that can cause X amount of damage when delivered. They see that they have 50

F-16's at their disposal for so many missions. Based on this, a certain overall amount of damage can be imparted on enemy targets. Given this amount of potential destructive power, the allied forces are capable of eliminating 20 petroleum refineries. With 20 petroleum refineries eliminated, the enemy forces will run out of fuel in 8 days. Therefore, allied forces will be able to stop enemy advances within 8 days. In doing so, the allies will be able to prevent the enemy from reaching the border.

In this example, the planner started with what he knew (aircraft capabilities), and worked up from there until he arrived at a high level goal (stop enemy before they reach the border). This approach could have branched off in countless ways and led to any of a large number of vastly different goals. The F-16s could have been equipped with other munitions, and there could have been a different amount of resources available. This would have resulted in a different amount of potential destructive power. From the level of destructive power, any number of possible destructive actions could be taken, which could change the overall outcome or goal immeasurably.

This is the problem with a bottom-up, or data-driven approach to planning. The ultimate goal is driven by what low-level information is known up-front. The goal is not known until the end. In truly effective planning, the content of the plans flows from high-level principles or goals. In Desert Storm, planning was a top-down process. It started with high level goals (e.g., minimize our casualties, fight war against Saddam, not against the Iraqi people, minimize Iraqi casualties, asymmetrically fight the war), which drove the rest of the planning. In this top-down, or goal-driven approach, the goals, or conclusions, determine the lower-level actions to be taken. This helps to ensure that the actions taken at lower levels (e.g., air assaults on tank units, bombing runs on refineries) further the ultimate goals of the effort.

Warden's comments:

You may want to consider a different example to illustrate the perils of bottom-up planning; the one you put in at least had a potentially useful and rational conclusion. Consider the following:

A problem erupts on the other side of the world. The Chairman asks someone to give him options. The group, composed largely of "operators" observes an aircraft carrier battle group two days away so recommendation one is to send the carrier. They then note that it has 12 attack aircraft aboard so recommendation number two is to launch 12 aircraft with supporting air defense aircraft. They see that no precision bombs are available so they need to find an "area" target on which to drop the bombs. They see that there is an airfield which should make a good area target so recommendation number three is to attack the airfield. They then realize that their recommendations need to have some pol/mil content so they observe that by striking the airfield, the US will have sent a powerful message and shown its resolve. Note that this process (which happens regularly) fails to define

objectives, analyze the enemy, choose targets in consonance with objectives, decide whether the carrier aircraft are the right tools for the job, etc. Nor does this process lend itself very well to predicting outcomes, enemy responses, public affairs ramifications, etc.

With respect to high level goals in Gulf War planning, minimize casualties etc, were precepts which needed to be followed in order to bring the real high level goals to fruition. The real high level goals (in order) were: a better post war situation in the Middle East brought about by reducing Iraq to a minor power in the area vice a regional superpower, keeping the oil market as stable as possible, getting Iraq out of Kuwait, etc.

5. **Strategy to Task versus Centers of Gravity.** Warden pointed out that he sees his Centers of Gravity approach as different from Glenn Kent's Strategy to Task approach. The Strategy to Task approach is very linear and sequential; it is too difficult to carry out in the real world. In contrast, an emphasis on grand strategic and strategic objectives makes the Centers of Gravity approach adaptable to any situation. (FYI: Glenn Kent is a retired Air Force three-star, currently at Rand Corporation.)

6. **Context and Objectives.** Intel people are tasked to gather information that planners need to develop the plan. Warden made it a point to include representatives from the Intel community during planning sessions at Checkmate. By including them, Warden ensured that the Intel people had a sense of the context in which they were to gather information and a clear understanding of the objectives. Knowledge of why the information was needed and how it was to be used provided the Intel people the background needed to conduct much more effective searches for information.

   The implication is that context is important. Clearly the pilots could benefit from a better understanding of the objectives behind the missions they are flying. The way in which information is currently passed to the pilots who actually fly the missions in the plan, strips away context and does not emphasize the larger objectives. The Air Tasking Order in its current form makes it difficult to pass along commander's intent, higher order objectives, and other contextual information that may be of use to the pilots.

Incidents

1. What may be a tactical success is not necessarily a strategic success. In Somalia, a small unit of troops independently planned an attack in which they killed 2000 Somalis while keeping their losses to only 17. Tactically, this was a great victory for the unit. However, the unit was not aware that this action went directly against the larger objectives of the war. The incident was a disaster to the strategic plan in that it forced the U.S. to withdraw from Somalia.

2. Warden endorses using the 5-ring model to plan air campaigns. The model states that there are five factors around which every organization is built: the leader, system essentials/energy conversion, infrastructure, the population, and defensive/offensive mechanisms. Thus in order to combat an organization, these are the aspects that one should disable or destroy. The process of the 5-ring model entails beginning at the highest level within each category and jotting down what is known. For example, in the Gulf War the highest level of leadership was Saddam Hussein. From the highest level, the planners progressively deepen, identifying what is known and not known. (Note that the planners will go across the rings to identify the highest level(s) within each before deepening to the next levels within the categories.) In this incident, the planners identified that electricity was a system essential of Iraq's because it is the country's source of power. The question thus became "how can we disable the electricity within the bounds of our overall objectives?"

   The first option considered was to take out the generators. However, this action would not support a major objective: keeping destruction to a minimum so that Iraq would not be destroyed financially and so that they would be able to function close to 100% the day after the war ended. Another thought to keep in mind was that they were fighting Hussein, not the Iraqi people.

   From the generators, they went down a level and investigated the possibility of taking out the switches. This action would accomplish the same goal as if the generators were hit, with lesser damage to the country in the long run. Switches are much easier to repair than generators.

   As the information was condensed and finally put on the ATO, however, the plan became "target the electrical facility at [a certain location]." The lower level planners, not knowing the higher level objectives, in turn planned to hit the generators rather than the intended switches. Their reasoning was that generators were a big target, making them relatively easy to hit, and that destroying the generators would accomplish the objective (at their level, the objective was to target the electrical facility to knock out the power). The critical flaw here is that the ATO does not state nor even imply the overall objectives, so actions are carried out that meet tactical objectives but directly conflict with strategic or grand strategic objectives.

3. During one 5-ring session, the question arose as to whether a certain highway should be bombed in order to restrict transportation between two points. An Intel Officer spoke up and said that they would be wasting their time bombing that highway since the land around it was flat and thus traversable. The planning group took his word for it. Unfortunately, the Intel Officer was wrong; the group later discovered that if they had taken out that highway, they would have cut down the Iraqi's movement by about 90%.

4. At times the planners do not have the information they need to make good decisions regarding their planning. The 5-ring approach allows them to quickly identify gaps in knowledge. In one case, they were unsure as to how one would go about attacking a biological warfare facility without putting lives at risk. They knew that Anthrax was created

in the facility they wanted to bomb, but they didn't know anything about the properties of Anthrax. They knew that the U.S. had once manufactured Anthrax, and they were eventually able to get a hold of the director of the last U.S. facility to produce Anthrax. From him they obtained answers as to the properties of Anthrax so that they could determine the repercussions of bombing the biological warfare facility.

5. This is another example of using the 5-ring model to plan a target. The planners wanted to prevent Iraq from having access to petroleum. How do you knock out the petroleum supply? What about knocking out the pipelines? This would meet the objective to knock out the petroleum supply, but the pipelines would take time and lots of money to repair, so that action would not meet one of the higher objectives of the war (didn't want to ruin the country financially). So they asked the question, What are we really trying to get at? The answer: We want to take the fuel supply away from military vehicles. Where do the vehicles get the fuel? At some point down the line, the fuel comes from the refineries. How does a refinery work? What parts of the refinery are critical to producing fuel, yet are able to be reconstructed fairly easily? Their solution was to bomb the cracking towers since these structures would prevent the Iraqis from getting fuel but would not be difficult to repair after the war. This example illustrates the constraining of plans according to certain criteria which serve as filters for whether the plan is good or not.

Warden's comments:

> *The cracking towers might be expensive and difficult to fix after the war, but they were the most efficient key to shutting down a refinery. Since the refineries were primarily for internal consumption, shutting them down would have relatively less effect on external petroleum sales.*

6. As Warden was walking around the room, looking over the planners' shoulders, he noticed two planners putting air defense shelters on the target list. The planners knew that the shelters were nuclear hard, had comm gear within them, and were serving as backup command centers. These targets caught Warden's eye because they were not typical targets. (The number of targets to be put on the list was fairly low, therefore he was familiar with all of them, and the air defense shelters were not included on the list.) He was also concerned because he felt targeting the shelters might clash with other objectives. He asked the planners what the shelters were and why they wanted to hit them. Their primary reason for wanting to hit them was because they served as backup command centers. Warden then asked them about potential consequences of targeting the shelters. One possibility was that families of Iraqi leaders were housed in those shelters. Since one of the overall objectives was to minimize the loss of Iraqi lives, bombing the air defense shelters was not an acceptable option.

   Although backup command centers were included in the list of things to target, air defense shelters were not. The planners were focusing on the aspect of the shelters that had to do with command centers, not on the other possible uses of these shelters, for example, temporary

housing for families. Warden noted that he tries to pay attention to a range of features when evaluating targets. These include:

- Things blatantly missing. Warden has expectations about what should be on the target list. He is looking for things that are missing.
- Proximity of targets to other structures. Warden is always thinking about the consequences of dropping a bomb. If the bomb hits the target, what will the consequences be? If the bomb is close, but misses the target (a common occurrence), what will the consequences be?
- Something that will clash with other objectives. While it may be an objective to take out the electrical system in a region, the planner must consider whether the method proposed will violate any other objectives (minimize collateral damage, don't cause so much damage to the region that they cannot recover financially, etc.).
- The consequences. Warden always encourages planners to consider the consequences of any target, regardless of its priority level. It is important to consider the political, financial, and personnel costs of every action.

7. It was proposed that B-52s be flown over Baghdad to drop bombs on a railroad yard. Although it is common to use B-52s for this type of mission, Warden was unsure whether this would be a productive move in this situation. He began to explore potential consequences of this action by asking himself and his team the following types of questions: What is the likelihood that the bombs will all fall on the railroad yard? Are there buildings near the target area that absolutely cannot be hit? What are the potential political ramifications of missing the target and hitting a nearby building or other structure? How sure are we that the B-52s won't be shot down? Is the railroad yard in an area where we could successfully protect the B-52s with our own fighters? If we sent fighters with the B-52s, how would the enemy respond? The purpose of these types of questions is to determine the risks involved in the operation so that they can be weighed against the potential benefits. The questions also serve as checks on whether objectives are being met. Warden remarked that it is important to ask planners the *why* questions, to keep them looking for better alternatives, and to make them consider whether their particular solution works within the context of the situation. In this case, it was decided that risk of missing the railroad yard and causing significant collateral damage or losing the B-52s outweighed the value of hitting the railroad yard. Even though B-52s are typically used for this type of task, in the specific instance they were not a good solution.

8. On the fourth day of the war, Gen. Schwartzkopf briefed that the Iraqi Air Force had been defeated and that the U.S. now had air superiority. After a few hours, the planners got together to discuss the briefing. What do we think about the claim that the U.S. now has air superiority? This claim was based on the fact that the Iraqis had stopped flying. However, how does a country usually gain air superiority, and do the events of the war thus far fit into our template for how air superiority is generally gained? Usually a country gains air superiority by defeating another country's AF, as evidenced by something like a bunch of Iraqi planes off smoking somewhere. Something was missing from this picture, and

Checkmate planners had a general sense of discomfort with the claim that the U.S. had air superiority. It was possible that Iraq could have been holding its AF in reserve. Why would they do this? What would they be planning to do? They may be planning to attack us later after we've assumed that they have no AF so that they can catch us by surprise. What can we do now to prevent that from happening? The Checkmate planners considered knocking out a significant portion of the Iraqi AF the following day. Since there were potential political ramifications of such an action, they planned to prevent a surprise air attack by destroying Iraqi AF shelters rather than the aircraft. The plan was successful and the U.S. gained air superiority.

Warden's comments:

> *We chose to hit the aircraft shelters because we knew with high probability that there were airplanes in most of them and that this was the simplest, most effective way to destroy the Iraqi Air Force and ensure that we really had air supremacy. The only political factor here was that associated with the announcement that we had air superiority when in fact the Iraqis had the ability to make it look as though we didn't--with probably adverse world and domestic ramifications.*

9. General Glosson, the leader of the Black Hole in Ryad, emphasized security and secrecy. As a result of this, the ATO was sent down to the wing without written documentation of the overall plan and higher level objectives. This meant that the wing could not see the larger objectives reached by bombing each target, and could not prioritize the targets. They were only aware of which targets were high priority when someone from the Black Hole actually called them and told them which to pay special attention to.

APPENDIX B: Warden Paper on Plan Quality

Contract # F30602-95-C-0216

A Good Air Campaign Plan

and

How to Measure It

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There are two ways to do campaign planning: the bottom-up approach—see what tools (aircraft, tanks, ships) are available and see what can be done with these tools; the top-down approach—start with the highest level political (grand strategy) objectives and work down. The first approach can lead anywhere and has a bad historical record. The second provides the highest assurance of success.

Question Set 1: Did the planners use a top-down or a bottom-up approach?

In outline form, the top-down planning process is as follows:

- Develop or receive grand strategic objectives which will define the peace which is to follow from the conflict and develop very broad military objectives;
- Perform a strategic level analysis of the enemy to find centers of gravity related to political and military objectives and to identify those centers which must be affected to realize goals;
- Develop a campaign concept of operations which includes forces to affect enemy centers of gravity, deception, information warfare, public relations, and logistics;
- Develop an execution plan at the appropriate level of detail;
- Decide how to terminate the conflict to include peace terms, location, and methodology to secure agreement, and how to maintain the gains through some combination of occupation, economic embargo, intimidation, or material assistance.

Question Set 2: Did the planning process follow the top-down process?

The primary—and in the final analysis the only vital—measure of an air campaign plan or any other plan is whether it takes the user of the plan from one state to a state better than would have existed in the absence of the plan. That is, we conduct air campaigns to improve our situation.

Wars are fought to secure a better peace. An air campaign is an integral part of war. Thus, the air campaign should contribute measurably and clearly to achieving the better peace. Likewise, to the extent that an air campaign is a part or a phase of a multi-campaign war, it should very clearly move the overall operation from one state to a more desirable state.

Question Set 3: Did the designers of the plan start with grand strategic objectives (a better peace) and work down to create the plan? Does every element of the air campaign plan clearly contribute to achieving a better peace? Are there any aspects which will have adverse effects (like too much collateral damage)?

[Note: many officers will be uncomfortable with the idea that they must make military operations at every level support high political objectives, but it is absolutely imperative that they do so. It is especially imperative in the CNN age where everyone from the President to citizens of other countries will instantly see

mismatches between military operations and declared or implicit political objectives. In today's world, there is no such thing as a purely military operation —at any level.]

The planners must develop military objectives which are in consonance with the political objectives. These objectives must be fairly broad because they should not force a particular campaign or operation, but must be sufficiently explicit to serve as the base for the campaign and to give lower level planners and users an understanding of why they are doing what they have been asked to do. Understanding the "why" is crucial because the conditions are likely to be different than anticipated when units prepare tactical plans and when aircraft prepare to release ordnance. When tactical units encounter divergences, they must either ask for clarification which will mean delay, or they must come up with a way to deal with the new conditions. The latter is by far the better choice, but will only be successful if the tactical unit has a thorough understanding of higher level objectives.

Question Set 4: Are political and military objectives enunciated in such a way as to be thoroughly understandable at tactical unit levels? Have higher headquarters made every effort to share all their information with lower levels or have they decided to hide some or all of it?

Strategic and Operational analysis of the enemy must be done using some kind of systems approach. One such approach is the Five Rings. If a systems approach—a top-down systems approach—is not used, the analysis of the enemy is likely to be incomplete. The purpose of the analysis is to find centers of gravity which, when affected, lead to realization of political and military objectives and which show the most effective way to reach the enemy.

Question Set 5: Did the planners use a systems approach to analyze the enemy? If not, can they explain why they chose not to do so? Does the plan clearly delineate real centers of gravity and link them explicitly with the political and military objectives to be attained by affecting them? Does the analysis show probable deterioration rates of the enemy and times and cost to regenerate either during or after the war? Does the analysis show connections between subsystems? That is, does it show the effect on ground force movement rates if vehicle fuel has been cut off or the effect on the enemy water supply system if the electric system is shut down? Does it show synergistic effects such as the effect on military communications if civilian communications are shut down? Does it show innovative targets which if hit may produce multiple reactions?

The concept of operation for the air campaign plan must describe what the plan is trying to accomplish, its general approach ("conduct focused attacks against selected centers of gravity in order to impose short term paralysis on the enemy"), its major precepts (war is against the leadership of the enemy or some particular class, collateral damage is to be avoided at all costs, friendly losses must be minimized, etc), the targets to be attacked and the order in which they should be hit, the tools to be employed (manned aircraft, information weapons, special forces,

etc), the expected sequencing—of events (approximate numbers of sorties to be flown in a general timeframes), and how success of execution will be measured (paralysis of systems, effect on target function vice destruction, the intelligence assets to be used to collect information (such as satellites, manned aircraft, spies, infiltrators, etc). Included in this latter area should be discussion of what changes in plan look appropriate in the event success is not occurring as desired. Also to be addressed in this part of the plan are broad observations, directions, and concepts for logistics, basing, deception, public affairs, participation of coalition partners, treatment of neutrals, etc. It is very important that all of these areas be addressed sufficiently that lower level officers can work out the details. A campaign plan is not an Air Tasking Order! In this section also planners should explicitly deal with possible enemy reactions and what will be done or why nothing need be done.

> (Note: Some approaches to planning put great stress on enemy capabilities and plans. Many of these (if not most) then end up allowing the enemy to affect their plans unduly. The object of planning is to take such actions as are necessary to put the enemy in an untenable position. This is especially applicable for US operations in the foreseeable future where it is difficult to conceive of a situation in which the United States will not have objectives which can only be met through offensive operations. A good way to handle the "enemy" is to set up a Red Team which has the job of finding holes in the campaign plan or to come up with ways to thwart it. The team should have full knowledge of what is being planned—but should not have responsibility for it.)

Execution of the plan will largely be the responsibility of lower level units. The plan, therefore, should provide those units with the information they need (or tell them how to get the information). To help executing units understand exactly what they are to do, it helps enormously to have representatives from as many subordinate combat and support levels as possible to participate actively in the planning process. Likewise, it is very important to avoid the game of hiding information. Security and compartmented classifications typically hide far more information from those on your side who need it than they hide from the enemy. In today's world, exploitation of information, not concealment of it, is the secret to success.

> Question Set 6: Have the planners developed a concept which leads to achieving the desired political and military effects? Does the plan make it clear what is to be done and in what sequence? Does the plan clearly explain what can and cannot be done? Does the plan lay out an understandable concept of operations which can be put into effect by lower echelons? Does it cover those complementary operations such as public affairs and deception which are crucial to success of an air campaign but which air planners frequently ignore through ignorance or the mistaken belief that someone else will do them? Does the campaign plan avoid giving instructions to lower level units which they should work out for themselves as a function of the situation at execution time? Have security and classifications been kept at a very low level to ensure that the large number of people who really need to know what is going on are not prevented from doing so?

(Note: this is a serious problem that can lead to catastrophic outcomes if not solved.)

The actual execution part of the plan may be an Air Tasking Order or some kind of Mission Type Order.

A good campaign plan has clear exit points and shows explicitly how to identify success. It lays out the mechanics of the end game. Thus, it should have explicit reference to termination terms. It should lay out the responsibilities the air arm (for an air campaign plan) will have in the post war situation. It should describe their application in civilian relief operations, repatriation of prisoners, air occupation, extended economic blockades, control of enemy communications and media, and response to violation of peace agreements. This part of the plan should take into account the probable availability of forces and bases after the war.

> Question Set 7: Does the plan explicitly address war termination and the role air forces will play? Does it provide for the introduction as required of units which did not participate in the conflict? Does it address demobilization of reserve and guard units as applicable? Does it address which units will return first to the United States and why?

Reevaluation is the last step in the process. After all is done, the planners should review their work mercilessly.

> Question Set 8: Did the planners conduct a vicious review of their own work to find flaws or new opportunities? Is the planning and execution process sufficiently flexible that it can respond very rapidly to the inevitable influx of new information and new direction? Are communications channels available from the highest political levels to low operating levels to ensure free flow of information?

APPENDIX C: Horner Interview Notes

Contract # F 30602-95-C-0216

General Horner (AF, Retired) Interview Notes

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Planning Issues

- Initiative. Gaining and maintaining the initiative buys you, among other things, flexibility; it enables you to adjust for unforeseen contingencies without severely disrupting the plan. General Horner's philosophy during the air war was "I want initiative. I choose initiative over optima. Planning seeks perfection in execution. Initiative does the best it can. But when you have 50,000 people's initiative working vs. one person's initiative, you will kick the hell out of anybody." A good plan never yields the initiative.

  Maintaining initiative includes shifting priorities, and focusing on the events at hand. As the Iraqis pushed south, there was a concern that if they managed to get in between the Syrians and the Egyptians then they would be difficult to get out. So when the coalition saw pictures of BMPs lined up on the burm they knew something was going on. This was one of three attempts made by the Iraqis to take the initiative. This example is described briefly below, then followed by a second example. A third example is described in the next section "Flexibility".

  Iraq Initiative #1 (Kafche).

  On one occasion, US forces obtained pictures of BMPs on a berm. Horner knew something was up, but didn't know what. So he sent out some CAS aircraft to address the problem. They were supposed to receive instruction from comm sites in Kafche that were under Marine (DASC) control. However, the DASC never picked them up, and they continued on out of the area and were finally picked up by JSTARS. The Marines thought the Iraqis were coming after a Marine supply dump in the area, so they were more worried about protecting their supplies than initiating comms with the CAS aircraft that were sent. The Saudi national guard went in town the night of 29th and rescued the DASC. They lost about three men,... But they got them out and then the next day, Collin had (a) brigade head north, the national guard came in from the south of town, and the Marines come over to provide air support and attack helicopters. Meanwhile, we were just bombing the (heck) out of the Iraqis.

  A second example where the Iraqis tried to take the initiative involved an attempted air strike on an oil field near Dahran. This involved Iraqi air power crossing over into coalition air space.

  Iraq Initiative #2. (Mirages). During Desert Shield, the Iraqis had been running training exercises in which Iraqi aircraft took off out of Kuwait City and went out over the water, then turned back in towards land. They were rehearsing, but US forces didn't know that at the time. However, on one occasion, three or four aircraft took off from an airfield right on the Iranian border. Rather than ducking immediately into Iran, they headed north along the border and then ducked in. Two F-15's had the lead, and they took off fangs out at mach nine. Once they cleared north, two Mirages took off and went out low level, underneath another Iraqi aircraft. The AWACS picked the Mirages up as soon as they broke ground, and called the AEGIS cruiser, which was holding two F-14 CAPs. However, for some unknown reason, the AEGIS refused to release the CAPs. Then, the AWACS lost the picture due to a systems problem. The Eastern Area sector picked up control and had Marine, Army, and Saudi assets locked on to the Mirages. A young Saudi pilot

was eventually directed to hit the Mirages, and he splashed them both. It turns out that the Mirages' targets were some oil fields south of Dahran.

The Iraqis had a well-executed rehearsed plan in this case, but since our defenses were so deep they were not able to accomplish their mission. However, it was a minor victory for the Iraqis, since they were able to get into air space south of Kuwait (although they lost two lives and two airplanes doing it).

- Flexibility. Although flexibility is a luxury bought by attaining and maintaining the initiative, flexibility, in and of itself, is a specific issue. In Desert Storm, the US held the initiative throughout the war, so any changes or adjustments that were made had a marginal impact on the overall plan. They were able to divert sorties at the last minute because there was not an absolute need to hit the targets for which they were designated (i.e., "it doesn't matter whether we hit Target A today or tomorrow"). In order to divert the sorties, a *sortie change sheet* would be filled out in the AOC, the necessary deconflictions would be carried out, and the change sheet would then be handed off to the AWACS. At that point, the team who had originally built that day's ATO would be on the AWACS (see issue # 7). Since they would be controlling the current operations and thus know where all the aircraft were at that point in time, they were the best people to determine which sortie would be most easily diverted, and then execute the diversion.

  The first actual attempt to take the initiative on the Iraqis part, involved a planned air strike using Badger Bombers. This event is described briefly below, as an example of the ability to divert needed resources.

  Iraq Initiative #3 (Tokadun). Iraq's first actual attempt to take the initiative was when they attempted to load Badger with medium-sized bombers for a planned air strike. Intel did not know anything, until McConnell in DC acquired information derived from national assets about the bombers and relayed that information to General Glossen in the Black Hole. Glossen and four other colonels ran straight to the AOC, filled out a change sheet to divert six F-117 sorties (F-16s probably would've been better for this sort of mission because they have GPS, whereas F-117s don't, but Tokadun was a high threat area, and it was night), and then had that information passed up to the AWACS, who passed instructions on to the flight deck. Four out of six Badgers were destroyed on the ground.

- Decentralization of Command. Horner's goal was to decentralize the command; for him, the person who was out there in the thick of the battle should be making the decisions, rather than the person a few hundred miles away sitting in a calm, air-conditioned room. He explained, "the element that the AWACS and JSTARS brings is human beings on the battlefield. The current philosophy is to centralize the information and bring the decision making to a nice calm, sweat-free environment. That is exactly the wrong thing to do, because much of the knowledge that is needed to make decisions is gained from being in the environment. I can't make that point enough." Furthermore, a good plan calls for a decentralized execution, since the conditions of the situation can change rapidly. To facilitate

decentralization, he strove to maintain an environment in which people made decisions based on the plan, rather than having to adhere to decisions already made for them by the plan. This decentralization is exemplified in the following two Special Operations incidents in which aircraft were easily diverted by the AWACS.

Special Ops #1. This incident demonstrates the flexibility we had attained during the Gulf War, and how the Special Ops planners failed to take in, or were simply surprised, by the geography of the area. A Special Ops team dropped in behind enemy lines, and had planned to dig themselves in and cover up, but the ground was like concrete, and they were stuck there with no support and nowhere to hide. They resorted to hiding in a ditch, but a young boy on his way to school noticed them and told the other villagers. Soon the Iraqis came after them. Unfortunately, the team had thrown their antennas away and so could not easily call for help. Eventually they found a creative way to call in, and the AWACS was able to divert some F-16s to drop bombs on the Iraqis near the Special Ops team.

Special Ops #2. This is another example of how flexibility within the plan was demonstrated. A Special Ops team was run into a swamp, literally up to their necks in water, surrounded Iraqi troops who were walking around trying to find them. Again, F-16s had to be diverted by the AWACS to get them out. Having the initiative, and having flexibility built into the plan allowed them to make this possible. Aircraft could be diverted without causing any critical impact on the overall plan.

- Prisoner of the Plan. Becoming a prisoner to your plan means that you attempt maintain, or hold onto, your plan even when it has become obsolete. Horner emphasized that it is inefficient to plan more than 2 ½ days out. He reasons that war is chaos, so it is impossible for a plan to take into account the changes that will occur in two days, which means that a plan more than 2 ½ days old will not accurately reflect the current situation, and won't be at all applicable to the current situation.

"I would not allow them to do detailed planning because I wanted us to have the ability to react to real time situations."

Often, the planners would begin to plan for Day 4, just because they knew that a plan would be needed for that day and had some time on their hands to look ahead. Horner strictly forbid the planners to do this, knowing that if a Day 4 plan had been started, he and his planners might fall prisoner to that plan, even knowing that it was obsolete; it is difficult to change your mindset to reflect the current situation when you've been planning for the situation as it was a few days ago. For example, if we would lose the initiative, we would be stuck.

General Horner's philosophy was to "create an environment where people make decisions. I didn't want an environment where people were trying to enforce (policy)."

"You have to create the environment where people feel free to ask any questions they want. Because if they feel intimidated by you, you cut off your nose. If they're excited about

something, they want to come share something. They've done something good. — if they have an honest question, if they think you're screwing up."

- Plan Through the Enemy's Eyes. While planning, it is important to look through the enemy's eyes to determine what actions will have an adverse effect on them. In Desert Storm, the US did not do a very good job of this. We did not take into account their culture and Hussein's priorities. We assumed they'd react like Americans would react, so we failed to identify the proper leverage points. For example, we went after the Baath Party headquarters with the intent to embarrass Hussein in front of his people. However, we failed to take into account that Hussein does not care about his people, nor does he care about the Baath Party headquarters. Our time and resources would have been much better spent had we gone after his secret police headquarters in every village in Iraq. This would have both hurt Hussein, and made the civilians grateful (since the secret police were known to harass the civilians).

A second example where we did not plan well through the enemy's eyes was when we hit three identical bunkers in one night.

"Well, we didn't know that what they were using, was an air raid shelter. It was a command control bunker. You know it's a very low priority target. We hit three identical bunkers that same night, one of them was the air raid shelter, the next day they were hauling dead women, children out. Quite frankly, if you read, the Kuwaitis have published a dairy of an Iraqi soldier, and his family lived near that bunker and he was absolutely irate. So it was actually a shot in the arm for the Iraqi Army."

General Horner also provided an example of how he tried to get "into the head" of the opposing commander and experience the war from his perspective.

"What happened is, Saddam Hussein plan was roughly this. Dig in with minimal defenses, the United States Air Force would come at me, I run out of ammunition in about two days and nobody ever got to see my air power anyway. We fought the Iranians for 10 years. They had the United States Air Force with F14s, F5s, F4s, ... So Americans come across, they (come at) .. my... divisions. They take some blows and then the Americans are somewhat weakened anyway and I hit them with my armor. And I either win the ground battle with my battle harden troops or I inflict some many casualties on the Americans, that the Times Square and White House demonstrations cause them (to pull out), and I'm Mr. Hero as it is. Mainly, cause everybody tells that I'm good. Day one of the war, the Americans come, oops, worse than what I thought. Day two, I'm hurting. Day three, Oh my God. Day four, what's happening. Day five, haven't they run out of bombs. Day six, my God, they're destroying my army. Day seven, eight, nine, ten what are we going to do? All my men are dying. We're getting killed. We're starving. [This is all supposition on my part.] So take (my) armor division drive south, go down the coast as far as (I) can, inflict as many casualties as (I) can."

A second approach to planning through the eyes of the enemy has a more general focus. These include psychological operations. In this next example, the use of, as General Horner stated, "*diabolical, out of the box thinking*" was impressive.

(General) Glossen planned to use 80-90 drones over Baghdad to draw Iraqi SAM fire. As soon as the SAM radars went on, the US destroyed them. The result was twofold: many SAMs were destroyed, and the SAM operators became too afraid to turn on the radars and use the SAMs. In this example, deception was used to neutralize a threat without putting US aircraft at risk.

A good plan uses deception to give the enemy the illusion that you have more combat power than you actually do, that he's hit harder than he really is, and that believe more of the world is against him than actually is.

"Well, one thing you might have, you have to look at the enemy. So... say... we wanted Hussein to surrender, to force his decision to pull out of Kuwait. How could we influence him to perceive that ... his plan couldn't succeed? ... one thing we could do is that we could create the illusion of more combat power than they had. We could create him to perceive that he is hit harder than he is, so you've got to hit him, but in combination with hitting him, you've got to also make him think the damage was worse than it was. ...you've got to make him think that the world is more against him than what his buddies were telling him. He needs to get the story, you've got to feed him information that way, perceptions. And you've got to know if you bomb this radio tower, that will hurt your overall effort, you're better off exploiting it or something like that. So you need that kind of interactive thing, and I don't know what it is, it's something that does lend itself towards computers to match variables."

A good plan considers that certain forces, depending on their personalities, will not conduct certain operations. On the other hand, a counter-example of planning through the enemies eyes is underestimating the enemy. A good plan does not position friendly assets (e.g., ammo depots) close to the front lines. It does not just give the enemy good potential targets. The Marines had laid down a supply depot just south of the border. They never believed that the enemy would come south. Otherwise, the would never have left the depot undefended and so close to the border.

- Measures of Merit. In Desert Storm, Horner and others were not concerned about measuring achievements. They did not need all those statistics. Instead, all they needed was morale, equipment, and a strategy, and these were used to attack the enemy where he was weak. Statistical analyzes are dangerous because they make it easy for people to lie (as happened in Vietnam), and they're not necessary because discrete numbers are not the right kind of feedback. The type of feedback they wanted was at a higher level — e.g., the enemy surrendered quickly, so that tells us that we are hurting them, and therefore our campaign has been effective. They were interested in measuring the *output*, not the *inputs*. Statistics measure input — for example, sortie rates. What really matters are the outcomes. For example, friendly aircraft not getting shot down; enemy ground troops killed or held prisoner; high enemy desertion rates; and reduced enemy throughput to the front. These outcomes aren't measurable with numbers and statistics.

"Its not important how many runways you blow up, its only important on how many airplanes would get shot down, or how many times we have to change our ordinances,

because of Iraqi fighter planes made a pass at a flight. That's what counts. If we never blow up a single runway, but we never jetsam a single bomb (nor does a) single fighter (get) shot down or an airplane (get) shot down. Then who cares, so you gotta measure output, not input. And to often our statistical measures, measure input or levels of activity, they don't measure output."

"The problem we have is, that we are a statistical society, in a non-statistical world. War, the Army went to far, they picked up the correlation of forces... from the Soviets. They gotta have this, this and this. Well, we just proved that's absolutely wrong in Desert Storm. Three to one, on the attack minimum, preferably five to one, well you saw what the Marines did to the Iraqis and their sector. Ate them alive. So you know the big BDA brouhaha, that's strictly, how does the Army do a better job of score keeping so that they can implement their statistical analysis in order to show they are going to win the battle. The battle's won by people with moral, equipment, tactics, strategy and every accommodation around. We can get our butts kicked by a third class nation nowadays if all they have to do, is just know how attack us where we're weak. The Iraqis could have won that war, simply by invading Kuwait, two days later saying oh, we shouldn't have done that. And pulled back to their Northern oil fields. Nobody would have sided with Kuwaiti, they got the city back, they got their country back, except for a bunch of sand. And meanwhile, Iraqis are sitting on top of the whole oil field, now what do we do. I mean, we could barely go to war where they were cutting off civilians heads with saws, and burning people up."

Furthermore, some effects are not easily definable. For example, when it was decided that the ground war would not commence until through the use of air power the Iraqi Army had been reduced to 50%, what is 50%. Is that 50% of the total numbers of tanks?...50% reduction in capability?...50% loss of life? In actuality, 50% became just a number, something to use to their advantage when marketing the plan. Gen. Horner believed we should prevent ourselves from becoming a "slave to the numbers".

"Schwarzkopf sat there and I'd be sitting there. But I would never said to him, 'We got 150 tanks last night.' Because the next night,.. 'How many tanks you kill?'. 'We got 100.' 'Well, what's the matter?' See, so, the statistical analysis that we so desperately seek as a data management society, is very dangerous thing. So yes, you have to have some sort of feedback, but first you start dealing in discreet numbers, you're sitting yourself up for either (A.) what have you done for me so far, (B.) being mislead by the enemy... Pretty soon, you become a slave to the numbers...That's what happened in Vietnam,... they started manufacturing numbers."

All in all, measures of effectiveness are observable. The output desired should be directly observable. For example,...

"One of the great,... anecdotes, (was) when we were suppose to meet with the Iraqis at the airfield. They called up and said they were in Botrain, and ... they are there and if they can't get to the airfield, (then) the highway system was completely wiped out. That made me feel real good. So we have to stay for an extra day. It, took an extra day(for them) to get to that airfield."

- Communicating Intent. There are at least two ways in which Horner ensured that intent was passed from his level down to the other levels of planning. The first was that a representative from the JFACC cell would physically bring the plan to the lower levels, brief it there, and allow for a question and discussion session. This continued on down the line, and even pilots would be briefed prior to their flights. A second way by which intent was passed down was through liaison officers. The JFACC planning staff was rotated such that the current ATO was always being executed by a team which included at least one of the planners of that ATO. The purpose of this system was so that rationale and other information would accompany the ATO, in the form of the liaison officer.

  "...then what we did was, each position, each wing had a representative on the staff plus, the guys in the black hole would go fly missions, and the guys in the staff would go fly missions. So we knew that the staff, in regards to what's going (on), in the field, and we had the field coming to the staff knowing what was going on there."

  "What I tried to do is create an environment where there best ideas, would become the plan. I, again, I would love to take credit, but I can't."

  A related issue to communicating intent addresses when information coming in to the planning cell is absent or misleading. In the following example we almost shot down our own Special Operations Blackhawk helicopters due to a lack of communication.

  "One of the problems we had was the loss of the AWACS link particularly when ships would come on station and they'd enter the link at an inappropriate time and crash the whole link. That was a very serious problem and we were constantly working the AWACS link. We almost had a case to shoot down of special operations helicopters because they did not provide their liaison sufficient information for him to provide the TCC4 about an operation they had going on... Because they did that they almost lost two Blackhawk helicopters one night. We had AWACS that curved the F-15s into fire and fortunately Mike Reevy caught it on the floor, didn't believe the Iraqis were in this location, they thought they were probably friendly airplanes, then finally he pressed the special operations guy that contact his headquarters or whatever and the guy came back white as a ghost and realized that we'd almost splashed two friendly helicopters."

8. Marketing the Plan. A major part of the planning process is being able to "sell" the plan to one's own superior. No plan is good unless it receives the approval of the commanding officer(s).

   Evacuation of Kuwait City. This example demonstrates the point that political objectives (evacuating American citizens) were not militarily achievable. Americans were pinned down in Kuwait City and surrounded by Iraqi forces. The evacuation could be planned, but the plan would not be executable. An evacuation would require US forces, perhaps via helicopter, to enter an area defended by the enemy, which means that the US would first have to neutralize the threat. However, this area was very well-defended, so it would be impossible to neutralize the threat to an acceptable level without destroying the entire city. Clearly, due to political ramifications (the extent of collateral damage would have been massive) and military cost (it

would have taken 10,000 sorties to "kill" the city), total destruction of the city was not an option. (Also, since it would have taken our forces so long to neutralize the threat before going in after the American prisoners, the Iraqis would have probably killed them all before we reached them.) This was a case in which the political goal was not militarily achievable; it was an "infeasible operation."

The eventual outcome was that the Iraqis simply sent all the foreigners home. It turned out that a military operation was not necessary. Had the Iraqis NOT sent the Americans home, a better strategy than the one that was planned might have been to use a deterrent and threat. For example, Hussein might have responded (let the American hostages go) to *"If you touch the Americans, we'll wipe out all your oil refineries,"* or *"we'll level Baghdad."*

A suggested approach stated by General Horner, with reference to the incident of the evacuation of Kuwait City, could have been used:

"...the wise military planner was the guy who (would) do the planning, and then he would go out and brief the boss saying, 'I don't recommend we do that, but if you want to do it, here is what is involved'..." Using this approach you will be credible and not considered a 'nay' sayer. By attaining credibility, the boss will reach the conclusion that you are absolutely right, the plan was (unachievable)."

In addition, General Horner made a strong point about the validity of statistical models, how he avoided them (see the section on "Measures of Merit"), and how he also used them to market a plan. Statistical models are ideal, they do not incorporate such things as weather or mechanical problems. These models can cloud the reality of the situation.

"So, in other words, the model has the airplane flying, it has perfect (conditions), and the same operator. Well, this guy, first of all, is afraid of dying, so he is not going to fly straight and low. He's going to keep and eye out, and if the weather gets bad, he goes over here, ... And, this SAM guy doesn't want to die. He's got a Weasel firing a HARM missile at him, so he's got fear in his heart, and 9 times out of 10 his radar is broken because he has an Iraqi maintaining it. And, he drags it through the desert to get there. ...the model won't appreciate that."

The first model they used suggested that the war would be over in four days. This was not realistic. However, what Horner could do was to use this information to help sell the plan. By entering the planned sorties and matching them to target bases, the output looked quite favorable. You have to make...

"...the plans so it would sell itself. It isn't enough to have a good plan, you've got to sell it... it has to do with being able to understand what is happening."

As General Horner stated:

> *"My job as the air component commander is to sell air component plan to the CINC and he worries about selling to the Secretary of Defense. So I work his problem. His problem is selling something that makes him look good to the Secretary of Defense."*

Also, part of marketing the plan also involves coordinating among the different branches of service. Part of projecting air power includes understanding of what your counterparts on land and sea need. This does not mean relinquishing aircraft to them, but listening to what they need and letting them know how their plans can be supported, and making suggestions on how air power could better support them.

> *"Successful inter-operability is simply people sitting down and working together. If you understand land, sea, air, and space are functional operations that are all equal and you just mix them as best you can, you don't have any problem. Close air support works well. The dysfunctional part of close air support is when the corps commanders came in and tried to get 300 sorties each for preplan close air support which they had no idea what they were going to do with. As a result, we would have had airplanes sitting on the ground and had been very dysfunctional. The way we solved that is we provided air power over the battlefield, 24 hours a day, all the time and put in place command and control operations who can divert it to where the ground forces need it. It made the Army angry and after the war they talked about how they need to get to control air, but in reality if you look at the success of the operation, I don't think they have any complaints. And in fact most Army guys who were in the war have nothing but praise for the air power support they received."*

9. Plan Evaluation. The plan needs to be balanced and decisive...

> *"What you learn as a commander is, ..., if you're going to be a commander, if you're going to lead, than you learn to trust your own judgment. You're in charge, its your time to make decisions. You listen to other people, you seek advice, you worry about your own short comings, but in the final anaylsis, there is no answer till you make the mistake. And if you're wrong, people die. Then you quit or they fire you. I mean that's what you wind up (doing) as a commander. And if never want to do that, you shouldn't be a commander. The worst commander is the ones that are managers. Its better to be wrong, and be decisive, then to be wishy-washy. Cause if you're wrong, at least, you can trace where the problem is and fix it."*

When presented with an air plan by the planners at Checkmate, General Horner felt that the plan was unbalanced. There were no contingencies for what would happen after the operation had started, too many details. The concepts were there (e.g. hitting the SOCs and breaking up the centralized command), but there were no considerations for if the opposing army would move, or anything about how to keep them from moving; and it called for too many hits on runways. It did however provide excellent targeting information. Information that may not have gotten to the theater otherwise. Thus, a good plan is balanced. It uses the highest-payoff--lowest-cost resources, and it considers how it might affect future events and what the effects of those future events might be (e.g., forcing the enemy into autonomous operations — what happens then?).

A good plan will pass the common sense test...

> *"Common sense. There has to be room for common sense."*

We've taken this to mean that when mentally simulated, the plan works. A good plan does not allocate a large number of resources to something that the enemy can easily fix or compensate for. For example, bombing runways is an inefficient use of resources because it takes a lot of resources to destroy them, but they can be easily repaired.

> *"If it (the plan) didn't make sense, then we changed it and they went back to the drawing board. We had that on a number of cases."*

A good plan is not based on theory — it's based on reality. It includes some redundancy, and it understands and accounts for the different levels of time sensitivity. Different targets/operations have different levels of time-sensitivity that must be understood during the planning process. For example, C2 should be taken out in the first few seconds of war, as should highly time-sensitive mobile SAMs. On the other hand, chemical production facilities are not as time-sensitive.

A good planner can optimize resources because he/she knows the capabilities and limitations of assets and resources. As General Horner put it, " the most critical element in an ATO— tankers... If you could solve air refueling, you could figure out how to get the air refueling efficiently proportioned. The rest is easy." A balanced plan fits together.

> *"It all fits, that you had the right airplanes going to the right targets,.. you were exploiting the various capabilities to a reasonable level of efficiency. Understand in warfare, reason level of efficiencies is 5 or 10 percent. It (optimization) is gone."*

A good plan looks balanced. Large numbers of aircraft, too many details, and low level flights are automatic flags according to General Horner. They stick out. Something is wrong when he sees this. A good planner mentally simulates the plan, doing a feasibility check, a risk analysis, a complexity analysis, and a timeline feasibility check. In a sense, he "what-if's" the plan. And, a good planning process includes planners who have experience with the systems that are being used to execute the plan.

An example of a bad plan: An attack on a nuclear research facility included 40 F-16s when normal allocation would be about 4 aircraft per target. The attack didn't work well because the first few aircraft kicked up so much debris that the remaining aircraft could not see their targets. In this case, resources were over-allocated for one point in time.

> *"When you look, can you image being part of a 40 car caravan going down an interstate highway and people are shooting at you as you go along and you're number 40 versus number one. Number one got it pretty easy, number 40 trying to.. You get to weave in and out of center lines."*

Computer Support Ideas: Horner.

> *"One thing that would be very useful, is if you had the ability to run discreet elements of your plan so you could measure sensitivity. And the other thing we absolutely desperately need, is some how, I haven't gotten all the information because it's so classified, but some how, how to... collate the effects of dropping a bomb on a telephone exchange, or entering a virus into the command, or projecting on the command's patrol stream. Or,... exploiting it. You've got to make those decisions and they are variable decisions, and right now we have no way of bringing that all together. To me that was one of the biggest roles we had in the war. Because we had a lot of capability, but we never really used it efficiently, we used it hit or miss. And it really plays together."*

General Horner suggested a need for a simulation tool for presenting both what-if scenarios, and for projecting discrete elements of the plan to see how the elements fit with other aspects of the plan. We need to have some tool to help us reduce uncertainty about specific actions, represent them so that they are meaningful, and not represented as a statistic.

> *"The other thing..., we don't do well is collection management. Now the reason we don't do collection management well is because we never practiced it. In fact, we don't practice at all, we just think we do, but we don't. ... and we don't have access to stuff until the war starts."*

The second point he makes here is that we need an integrated information infrastructure. We need a reliable source of up-to-date information — information that we need to successfully run an air campaign.

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